THE CARL MOYER MEMORIAL AIR QUALITY STANDARDS ATTAINMENT PROGRAM (THE CARL MOYER PROGRAM) GUIDELINES –

PROPOSED REVISION 2000

July 27, 2000

California Environmental Protection Agency

Air Resources Board

EXECUTIVE SUMMARY

These are the proposed revisions to the February 1, 1999 approved Carl Moyer Memorial Air Quality Standards Attainment Program (the Carl Moyer Program) Guidelines. The approved guidelines provide local air districts with requirements for administering their local programs and criteria to evaluate and select reduced-emission heavy-duty engine projects. If approved by the Air Resources Board (ARB), the proposed revisions to the guidelines would apply to 2000/2001 and subsequent funding.

The Carl Moyer Program reduces emissions by providing grants for the incremental cost of cleaner heavy-duty vehicles and equipment. The grants are issued locally by air pollution control and air quality management districts that choose to administer a local program. Private companies or public agencies that operate heavy-duty engines in California apply directly to the local districts for grants.

The Governor and the Legislature made one-time budget appropriations of $25 million for the 1998/1999 fiscal year, $23 million for the 1999/2000 fiscal year, and now -- $50 million to fund the program in the 2000/2001 fiscal year. The ARB, the California Energy Commission (CEC), and the local air districts have been implementing the Carl Moyer Program for over a year.

Based on program implementation during the first year, the program is a huge success. Demand for project funding has been very high (far in excess of available funding), and the resulting emission reductions are extremely cost-effective. Statewide, the demand for funding was more than three times the available funds. In the first year the districts funded projects that include alternative fueled line-haul trucks, refuse haulers, urban transit buses, school buses, and tractors; some electric forklifts; and finally, some diesel to diesel repowers for marine vessel engines, and agricultural pump engines.

Approximately 40 percent of first year funds were used to fund alternative fuel on-road projects, 25 percent to fund marine vessel projects, 20 percent to fund agricultural pumps, 10 percent to fund forklifts, and the remaining 5 percent to fund other diesel repowers (mostly off-road equipment). ARB staff anticipates the program will reduce oxides of nitrogen (NOx) by about four tons per day (tons/day) and particulate matter (PM) from diesel exhaust by about 100 pounds per day (lbs/day). These reductions will continue for a minimum of 5 years, with some projects continuing to provide benefits up to 20 years. Overall, the program is very cost-effective – averaging below $3,000 per ton of NOx reduced based on district estimates for the first year projects. By comparison, controls on stationary sources cost between $10,000 - $20,000 per ton.

In October 1999 Assembly Bill 1571 (AB 1571 - Villariagosa/Brulte) was signed codifying the program. AB 1571 requires ARB staff to consider revisions to the program. AB 1571 also created the Carl Moyer Program Advisory Board (the Advisory Board), whose responsibility was to make recommendations on the need to continue the Carl Moyer Program, the amount and source of necessary funding for a continuing program, as well as to make recommendations for program improvements, if necessary.

Two major program modifications recommended in AB 1571, as well as by the Advisory Board, include a method for allowing funding for the incremental cost of fuel, and a method for determining PM reductions from the continuing program.

The purpose of this proposed revision to the Carl Moyer Program Guidelines is to address requirements listed in AB 1571, the Advisory Board's recommendations, as well as recommendations for program modifications made by local air districts. The proposed revisions have also been developed based on ARB staff's experiences with program implementation in an effort to ensure the integrity of the program. It is important that projects funded under this program continue to result in real, quantifiable, and enforceable emission reductions.

There are two parts to these proposed revisions. Part I is an overview of the program, along with a brief description of ARB's and local air district's progress with program implementation. Part II contains specific details pertaining to ARB staff's proposed revisions to the Carl Moyer Program Guidelines. Part II is organized by chapter and section as it appears in the approved Carl Moyer Program Guidelines dated February 1, 1999. Each section, however, begins with a brief explanation of the proposed changes in italics and followed by the proposed revised language for the affected section. If a section was not modified, the section title is listed followed by the phrase -- "No revisions". This indicates that ARB staff proposes no revisions for the section at this time.

PART I

PROGRAM OVERVIEW

PART I

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CARL MOYER PROGRAM OVERVIEW

A. Purpose of the Program

The Carl Moyer Program guidelines were approved in February 1999 and the program is entering its second year of implementation. The purpose of the Carl Moyer Program is to reduce emissions and help California meet its air quality obligations under the State Implementation Plan (SIP). Through this program, the districts can provide grants for the extra capital cost of cleaner-than-required vehicles and equipment that have traditionally been powered by heavy-duty diesel engines. In essence, the program buys critical near-term emission benefits that California needs to meet impending federal air quality deadlines.

B. Current Program

Any district can participate in the Carl Moyer Program. In order to participate, a district must apply directly to ARB and provide $1 in matching funds for every $2 that ARB provides a district to implement a local program. In addition, district funds must be used for projects that qualify according to the approved Carl Moyer Program guidelines. District funds may also be used to pay for alternative fuel infrastructure, as long as a district provides ARB with documentation showing that the facility is being used by qualified Carl Moyer Program projects. Lastly, districts may claim up to 15 percent of their matching funds as program administration. If a district chooses to participate in the program, the district evaluates and selects projects according to the approved guidelines. Projects can include on-road heavy-duty engines, off-road equipment, agricultural pump-engines, marine vessels, locomotives, forklifts, and airport ground support equipment.

In its first year, the Carl Moyer Program has been an overwhelming success. The demand for project funds exceeded three times the amount of available funds. During the 1998/1999 fiscal year, ARB distributed $24.5 million in project funds among sixteen local air districts. Forty percent of those funds were used towards alternative fuel on-road projects, 25 percent towards marine vessel projects, 20 percent towards agricultural pumps, 10 percent towards forklifts, and the remaining 5 percent towards other diesel repowers (mostly off-road equipment). Staff estimated that projects funded in the first year of the program would reduce NOx emissions by about 4 tons per day, and PM emissions by about 100 lbs/day. On June 30, 1999, districts participating in the first year of the program provided ARB with reports describing all projects funded.

C. Continuing Program

In June 1999, Governor Davis and the Legislature approved a one-time budget appropriation of $23 million to fund the Carl Moyer Program through a second year. Of these funds, $19 million went to ARB to fund engine projects, and $4 million to CEC to fund infrastructure and advanced technology development. Currently, in the second year of the program, ARB distributed over $18 million in project funding to 20 local air districts. Some districts have already obligated 1999/2000 fiscal year funds by selecting and funding projects based on the currently approved guidelines. Districts participating in the second year of the program must provide ARB with a program implementation report on or before September 30, 2000.

In October 1999, Governor Davis signed AB 1571 formally establishing the framework for the Carl Moyer Program. In accordance with that legislation, ARB developed and presented a report to the Governor, Legislature, and the Advisory Board on the progress of program implementation. The Advisory Board, with the assistance of ARB, CEC, and the local air districts, also developed its own report with recommendations to the Governor and Legislature to continue the Carl Moyer Program through 2010 at a funding level of about $100 million per year. As such, the Governor and Legislature approved a one-time appropriation of $50 million ($45 million to ARB for engine projects and $5 million to CEC for infrastructure and advanced technology projects) to fund the Carl Moyer Program through a third year (fiscal year 2000/2001).

D. Summary of Proposed Guideline Revisions

In order to ensure that funding criteria is consistent statewide, even though districts have different implementation schedules, it was necessary to move toward an annual revision schedule. Furthermore, AB 1571 was signed requiring ARB staff to make any proposed revisions of the guidelines available to the public 45 days before final approval. ARB staff is also proposing a number of revisions to the Carl Moyer Program guidelines that will affect projects funded during the third year of the program (2000/2001 fiscal year funds).

ARB staff developed some major proposed revisions to the guidelines as required under current legislation (AB 1571), and as recommended by the Advisory Board. Other proposed revisions were developed to ensure that emission reductions remain real, quantifiable, and enforceable based on ARB's and districts' experiences during the first year of the program. If emission reductions are not real, quantifiable, and enforceable, then the program would be funding benefits that may not be claimed in the SIP. Some of the major proposed revisions include new chapters to consider PM emission reductions and the incremental cost of alternative fuels. In addition, existing chapters were revised to include considerations for new default emission factors; alternative diesel fuels; discount factors for marine vessel emissions; and infrastructure costs for agricultural pump engines, etc. There were also some minor proposed modifications to correct discrepancies in the guidelines such as omissions and typographical errors. The following sections provide a brief description of the major proposed revisions. The detailed proposed revisions are provided in each chapter as it appears in the approved Carl Moyer Program guidelines, dated February 1, 1999.

Part I provides an overview of the proposed revisions to the Carl Moyer Program. Part II of contains the specific details.

1. PM Baselines

The Carl Moyer Program was designed to help California meet the NOx emission reductions in measure M4 of the 1994 SIP. Although, the focus of the program was to reduce NOx emissions, the Advisory Board, ARB, and local air districts recognize that diesel PM is also a serious public health concern and PM reductions are needed throughout California. Many of the technologies already funded under the program, such as electric motors and alternative-fueled engines, also reduce PM. AB 1571 requires that ARB staff consider PM reductions from the Carl Moyer Program. In fact, the Advisory Board established PM criteria through a public process and provided that criteria to the Governor and Legislature in a report. The Advisory Board's recommendations were that the Carl Moyer Program have a goal to reduce PM emissions by 25 percent statewide, except for areas that are designated as non-attainment for the federal PM standard. Those areas designated as serious non-attainment for the federal PM standard are <u>required</u> to reduce PM emissions by 25 percent on a <u>program</u> basis (not a project-by-project basis). Currently, San Joaquin Valley Air Pollution Control District and South Coast Air Quality Management District are the only two districts affected by this proposed requirement.

Based on the criteria recommended by the Advisory Board, ARB staff is proposing PM emission factors to calculate PM emission reductions from the program. PM emissions will be calculated similar to NOx emission reductions. As part of ARB's oversight of the program, ARB staff will determine overall statewide and district compliance with the PM reduction goals and requirements. If the program falls short, ARB staff will propose modifications to the program to achieve the necessary requirements. Specific details pertaining to PM are provided in Chapter IX of this document. Chapter IX contains specific details pertaining to calculating PM reductions.

2. Incremental Fuel Cost

The Carl Moyer Program as established pays the incremental capital cost of vehicles and equipment that are cleaner than required. Funding of incremental fuel costs is not currently allowed under the program. Cleaner alternative fuels and alternative diesel fuels (e.g. diesel-water emulsions, bio-diesel) are available that can reduce NOx and PM emissions. Some non-attainment districts have stated that they need the near-term reductions that those fuels can provide, and would like district funding for incremental fuel costs to count as match funding.

ARB staff is currently developing test procedures to evaluate the emission benefits of these alternative diesel fuels. Until those procedures are approved, ARB staff proposes to allow funding for incremental fuel cost on a case-by-case basis, and funding incremental fuel costs would be optional. ARB staff is requesting comments on the most appropriate way to incorporate funding for incremental fuel costs into the program.

3. Discount Factor for Dual-Fuel Engines Used Low Load/High Idle Applications

Dual-fuel engines are available that are certified to reduce NOx to sixty-two percent of the required NOx standards. One set of in-use test data shows that while these engines deliver full emission benefits in many applications, the emission benefits were 30 percent less on a low-speed, stop-and-go chassis cycle (the Central Business District cycle). ARB staff is working with a dual fuel engine manufacturer to collect additional information and more accurately determine the emission benefits in neighborhood refuse collection. Until such time as additional information is available, the ARB staff is proposing to discount the dual-fuel engine emission benefits by 30 percent in applications with a significant amount of low-load applications with significant amounts of idling (i.e. urban transit buses, refuse haulers, etc.).

4. October 2002 Diesel-to-Diesel Repowers

Under the current Carl Moyer Program, electronic-to-electronic repowers have not been allowed. This is due to the off-cycle NOx emissions that occured in many of the diesel heavy-duty engines manufactured in the early to late 90's. Under settlement agreements, many of the engine manufacturers must introduce new engines with significantly lower NOx emissions beginning in October 2002. Repowering older electronically controlled trucks with these October 2002 engines can significantly reduce emissions. ARB will allow October 2002 repowers under the Carl Moyer Program and staff is working to quantify the emission benefits.

A few districts have also expressed an interest in allowing mechanical-to-electronic engine repowers for heavy-duty on-road vehicles (pre-1987 model year engines with a 2002 model year engine). Although this strategy may provide very near-term emission reductions, there are challenges pertaining to the cost-effectiveness and technical feasibility with allowing mechanic-to-electronic repowers. From a technical perspective, for example, the electronically controlled engines are difficult to install in applications that were not previously electronically controlled. The fuel system and electrical system for these engines are completely different compared to a mechanical engine. However, staff understands that some districts may need to fund mechanical-to-electronic engines as a means of achieving immediate emission reductions in order to meet very-near term SIP commitments. Hence, staff proposes to allow mechanical-to-electronic engine repowers only on a case-by-case basis. ARB, in cooperation with the local air district, will evaluate the project and determine if the benefits are adequate to merit funding under the Carl Moyer Program. Specific details for on-road heavy-duty engine repowers are presented in Chapter II of this document.

5. Incentives to Replace Pre-1987 Heavy-Duty Vehicles

The Advisory Board recommended that ARB staff consider including a program to provide incentives to replace pre-1987 heavy-duty diesel vehicles with newer model year vehicles. In the past, a heavy-duty engine retirement program was considered by

ARB. However, it was a challenge to determine the remaining useful life of the old heavy-duty vehicle, and the emission benefits that could be achieved. Therefore, the heavy-duty engine retirement program was never implemented. Many of those same issues are still of concern with the incentive program. ARB staff has conducted a preliminary analysis of the issues and the potential emission benefits of an incentive program. Staff's proposal based on the results from this analysis, are described in detail in Chapter II of this document.

6. Update Emission Factors

ARB staff is proposing new NOx emission factors to reflect the recently adopted EMFAC2000 emission model (May 2000), which accounts for the settlement agreement between ARB and the diesel engine manufacturers (regarding excess NOx emissions from the use of alternative injection timing strategies). ARB staff proposes new emission factors for heavy-duty on-road vehicles based on the model year and gross vehicle weight rating (GVWR). These emission factors are listed in Chapter II of this document.

ARB staff also proposes new emission factors for off-road and agricultural irrigation pump engines to reflect portions of the new off-road model approved as of January 2000 that incorporates the most recent regulations for off-road diesel engines adopted by both U.S. Environmental Protection Agency and ARB. These emission factors are listed in Chapter III and VI, respectively.

It is important to understand that under the current Carl Moyer Program, agricultural irrigation pump engine repowers were very popular, with emission reductions well below the 25 percent reduction requirement listed in AB 1571. Using the proposed emission factors to calculate emission reductions from 1988 through 1996 model year engines would result in reductions less than the 25 percent requirement. Currently, ARB does not have the authority to modify the 25 percent emission reduction requirement, since that emission reduction requirement is a legislative requirement. Hence some agricultural irrigation pump projects may not be funded using the proposed emission factors.

7. Project Life for All Project Categories

Based on ARB's experience with program implementation during the first year, ARB staff proposes a specific project life be applied when determining emission benefits and project cost-effectiveness. ARB staff proposes that the project life be selected based on the remaining amount of useful life for the older engine. For example, an engine used in a newly purchased heavy-duty line-haul truck has a useful life of about 10 years; hence the selected project life should be 10 years. For a repower project, however, the remaining useful life would be less than 10 years in most cases (where the engine is pre-1987, the project life would be less than 10 years). In an effort to normalize the project life selected for each project category, staff proposes a standard project life for each project category based on whether the project is for a new purchase, an alternative fuel engine purchase, or a repower. The table below lists the proposed project life for each project category. The proposed project life is also listed in each chapter under the project criteria.

Acceptable Project Life		
Project Type	**Diesel to Diesel Repowers (life)**	**Natural Gas Engine or New Diesel Purchase (life)**
ON-ROAD [a]		
School Buses (≥33,000 GVWR)	N/A	20 years (NG only)
Buses (≥ 33,000 GVWR)	N/A	12 years (NG only)
Other	5 years	10 years
OFF-ROAD		
CONSTRUCTION	7 years	10 years
OTHER	5 years	10 years
LOCOMOTIVES	20 years	20 years
FORKLIFTS	N/A	5 years electric only
GSE	N/A	5 years electric only
AGRICULTURAL PUMPS	5 years	10 years
MARINE VESSELS		
FISHING/OTHER SMALL VESSELS	10 years	10 years
FERRIES/TUGS/LARGE VESSELS	20 years	20 years

Note: a. For on-road, project life may be based on years or the equivalent mileage.

8. Emission Calculations to Account for Activity Level Increase/Decrease

In general, the emission reduction benefit of a project can be calculated based on either the annual fuel consumed, annual miles traveled, or annual hours operated. However, ARB staff is proposing that when there is an increase/decrease in activity level or horsepower that is greater than 25 percent, emissions must be calculated based on fuel consumed. If the annual fuel consumption is used, an energy consumption factor should be calculated (based on the brake specific fuel consumption of each engine) and the activity level should be based on actual annual fuel receipts. ARB staff proposes that when the annual mileage or hours of operation is the basis for determining the emission reductions, the activity level be based on the vehicle odometer or hour meter. The details for calculating emissions are presented in each Chapter, for each project category.

9. Diesel Hybrids

A promising new heavy-duty technology being demonstrated is a hybrid electric engine system. Manufacturers of this technology are currently focusing on the transit bus market, but this technology could also provide emission reductions in other applications. Hybrid buses utilize an electric drive typically with an internal combustion engine (diesel or alternative-fuel) and a traction battery. Recent test data indicates that prototype diesel hybrid transit buses with a particulate filter and low sulfur diesel fuel can achieve PM emission levels nearly comparable to a current natural gas transit bus. The testing also shows this diesel hybrid technology does not produce the NOx reduction benefits of natural gas engines. Still, diesel hybrids are an improvement over current diesel engines in terms of emissions and efficiency. With further optimization, hybrid technology (both diesel and alternative-fuel) has the potential to significantly reduce both NOx and PM.

Current California and federal certification test procedures are engine-based and therefore are not able to adequately represent the emissions benefits of the hybrid technology. An effort is currently underway with the Northeast Advanced Vehicle Consortium, ARB, US EPA, and the engine and hybrid manufacturers to improve the certification process. Most of the effort, however, is focused on developing a “quick-fix” certification procedure. This process is not likely to provide a quantitative means of validating the in-use emissions benefits of the hybrid systems. Thus, it is proposed that diesel hybrid vehicle projects could only be approved on a case-by-case basis. Staff is proposing to determine the emissions benefits primarily based on the chassis Central Business District Cycle. Alternative-fuel hybrid electric vehicles with engines certified to low-emission standards would be eligible for funding under the Carl Moyer Program.

10. Discount Factors for Marine Vessels

The current guidelines establish a need to apply a discount on emissions from marine vessel engines based on the degree of uncertainty on the amount of offshore emissions that actually reach the mainland. The discount would be established based on the results of the Southern California Ozone Study (the Tracer Dispersion Study) that was conducted by ARB to determine offshore emission impacts. This study was completed in the early summer 2000, and results indicate that the emission reductions from marine vessels would reduce ozone, PM, and toxic emissions that indeed reach the mainland. However, there is still uncertainty on the amount of emissions that actually reach the shore. Hence, ARB staff proposes to calculate benefits from marine vessel projects based on emissions that occur within the district’s emission inventory boundary.

11. Agricultural Pump Electric Motors

The current program is designed to provide funding for the increase in capital cost between two engines (i.e. diesel engine versus electric motor). Electric motors for agricultural pumps, however, cost less than diesel engines and therefore do not qualify for incentive funding.

ARB is aware of the emission benefits associated with replacing engines with electric motors. Hence ARB evaluated two methods for providing the agricultural communities with incentives to convert to electric motors: funding to cover standby electric charges or funding to install the power line and peripheral equipment necessary for an electric pump. Current data provided by several utility companies indicated that the operating costs, which include standby (or demand) charges, vary based on electrical demand at each site, the type of irrigation system, and time of use (e.g., summer vs. winter, peak vs. off-peak), etc. Furthermore, standby charges may disappear in the near future, since at least one major utility has proposed to eliminate standby charges and reduce rates for select agricultural customers. This effort is being accomplished with support from agricultural communities. Hence, at this time, ARB staff does not propose that additional funding be utilized to cover individual standby charge costs.

ARB did find, however that the cost of the electric motor plus the cost to set up a power line and connect necessary peripheral equipment to the motor are comparable to the installed cost of a new off-road emission-certified diesel engine. Hence, ARB staff proposes to allow Carl Moyer Program project funds for the incremental cost to install the power line plus peripheral equipment. ARB staff also proposes to allow districts to fund the cost for extending the power line, provided that those funds come from the district and would count as matching funds. Any funds provided for a project must meet the cost-effectiveness criteria.

12. Expand Forklift Program

For the first two years of the Carl Moyer Program, funding for electric forklifts has been provided via a demonstration project in the SCAQMD. Under this demonstration program, SCAQMD staff was successful at incentivizing electric forklift projects that may likely have occurred without funding. In addition, the SCAQMD staff determined that it was appropriate to set a cost-effectiveness criterion of $3000 per ton of NOx reduced for forklift projects. ARB staff proposes to expand the forklift demonstration program statewide, with the cap in place.

13. Revisions Approved Before AB 1571.

AB 1571 requires a 45-day public notice of changes to the program. Some revisions were incorporated into the program before AB 1571 was effective. Those revisions include a change to marine vessel engine baseline emission factors, plus minor clarifications and typographical changes. Since these revisions were approved before AB 1571 was signed, and the districts have already incorporated pre-AB 1571 revisions into their local programs. These pre-AB 1571 modifications have been incorporated into Appendix B of this document.

PART II

PROPOSED REVISIONS TO THE FEBRUARY 1999 VERSION OF THE CARL MOYER PROGRAM GUIDELINES

PART II

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LIST OF APPENDICES

CHAPTER I.

PROGRAM REQUIREMENTS

A. Introduction *No revisions.*

B. Match Fund Requirements *Clarification only, no revisions.*

According to AB 1571 and the current approved guidelines require that districts must provide $1 in matching funds for every $2 of Carl Moyer Program funds provided by the state. Local air districts provide matching funds for the Carl Moyer Program primarily through motor vehicle fees. These matching funds (two-to-one match) totaled about $12 million in the first year. In order for the program to continue, matching funds are important and should be continued. The matching funds at the $45 million funding level would total about $22 million.

ARB and the Carl Moyer Program Advisory Board (Advisory Board) recognized that the ability of districts to provide increased matching funds would be challenging. Hence, the Advisory Board recommended (in its March 31, 2000 report) to the Governor and the Legislature that the current legislation be modified to include a cap on the amount of district matching funds at $12 million. Unless current legislation is modified, ARB does not have the authority to modify the matching fund requirement. Therefore, staff proposes no change to the matching fund requirement at this time.

C. Cost-Effectiveness *No revisions.*

D. Project Selection *No revisions.*

E. Projects Outside the Scope of the Carl Moyer Program *No revisions.*

F. Monitoring *No revisions.*

G. Reporting *No revisions.*

H. Timetable With District Milestones

Based on program implementation in the first year, ARB and local district staff found that it is necessary for the program to maintain a consistent schedule. A schedule provides program continuity with milestones for district reporting, initial funding disbursements, and annual guideline revisions. Most importantly, maintaining a schedule allows districts to operate their local programs using consistent guidelines statewide. Since the program is moving to a multi year program, staff proposes to revise the schedule listed in Chapter I, section H to eliminate any reference to the calendar year. The proposed schedule is listed below.

October – 1st week	Release of the draft revisions to the Carl Moyer Program Guidelines.
November – 3rd week	ARB hearing to consider approval of guidelines.
January – 3rd week	District/port authority applications to administer program due.
February	ARB review of applications to administer program.
March – June	ARB award of grants.
September 30	District report on implementation efforts due.
June 30	One-year district program report on project status due. Districts must report funds that are obligated under contract. Funds that are not obligated may be reallocated to other districts.
June 15	Second-year deadline for districts to have distributed program funds (purchase order issued).
July 31	Second-year district final report on program due.

CHAPTER II.

ON-ROAD VEHICLES

A. Introduction *No revisions*.

1. Emission Inventory *No revisions*.

2. Emission Standards *No revisions*.

3. Control Technologies *No revisions*.

a. Available Technologies

This section has been modified to include a third paragraph to elaborate on dual-fuel engines as an available control technology for heavy-duty truck applications. It also states ARB staff's proposal pertaining to dual fuel engines in stop and go applications. The new paragraph reads as follows:

Dual-fuel engines are available that are certified to reduce NOx to sixty-two percent of the required NOx standards. One set of in-use test data shows that while these engines deliver full emission benefits in many applications, the emission benefits were 30 percent less on a low-speed, stop-and-go chassis cycle (the Central Business District cycle). ARB staff is working with a dual fuel engine manufacturer to collect additional information and more accurately determine the emission benefits in neighborhood refuse collection. Until such time as additional information is available, the ARB staff is proposing to discount the dual-fuel engine emission benefits by 30 percent in applications with a significant amount of low-load applications with significant amounts of idling (i.e. urban transit buses, refuse haulers, etc.).

b. Emerging Technologies

ARB Staff proposes to add the following two sub-sections to discuss the viability of alternative diesel fuels, and diesel hybrids as potential project categories under the future Carl Moyer Program. The new sub-sections read as follows:

Alternative Diesel Fuels Over the years industry has produce various alternative diesel fuels (i.e. diesel water emulsions, bio-diesel, etc.) that may lower PM and NOx emissions from diesel engines, as compared to conventional diesel. Some of these technologies are emerging from the demonstration stage to a commercial product, while others are still in the research stage. As such, ARB staff has been evaluating whether or not to consider alternative diesel fuels that are entering into the commercial market as a potential category for reducing emissions under the Carl Moyer Program.

In its infancy, the Carl Moyer Program was designed to reduce emissions by applying control technology (engine hardware) that has been certified, for the most part, beyond the current standards. In essence, it has been a program aimed at providing the end users with an incentive to clean up their very old engines by replacing them with newer engines that have cleaner control technology. Under the current Carl Moyer Program, associated program reductions are easily measured and enforced. Engine technology is typically certified for sale in California by ARB, tested according to regulatory test procedures, and has warranties on components that reduce emissions. Hence the program provides real, quantifiable, and enforceable emission reductions statewide.

Allowing alternative diesel fuel as a category under the Carl Moyer Program may be viable in the future. However, some issues still need to be evaluated by staff before this option is allowed under the Carl Moyer Program. First, allowing this category would require ARB to move from a program that is currently focused on updating old engines (hardware), to a program that would allow diesel engines to remain in operation by simply changing over to an alternative diesel fuel. The manufacturer of the alternative diesel would need to demonstrate that the fuel is cleaner than conventional diesel fuel. Under the current program, engines must reduce emissions by a minimum of 25 percent in order to qualify for funding.

Second, the current program is designed to calculate emission reductions and cost-effectiveness based on actual usage (i.e. mileage, fuel consumption, or hours of operation) and the cost difference between engine technology. Although there may be a cost difference between the alternative diesel fuel and conventional diesel fuel, tracking fuel consumption for the alternative diesel fuel may be difficult. Currently, there is no method for assuring that an alternative diesel fuel is being used over conventional diesel, since vehicles may be able to continue operating on either fuel.

ARB staff is currently developing test procedures to evaluate the emission benefits of these alternative diesel fuels. Until those procedures are approved, funding for alternative diesel fuel would be allowed on a case-by-case basis based on the incremental cost between the two fuels. Funding for the incremental cost of alternative fuels (if any) would also be allowed on a case-by-case basis. However the alternative fuels would have to be used with a Carl Moyer funded project. ARB staff, in cooperation with the district, would evaluate the project to determine whether or not it would qualify for funds based on emission benefits and cost-effectiveness. Furthermore, funding for incremental fuel costs would be optional for districts. If funded, funding would come from the district and would count as a district's matching funds under the Carl Moyer Program.

Hybrid Electric Vehicles: Hybrid buses utilize an electric drive typically with an internal combustion engine (diesel or alternative-fuel) and a traction battery. Current California and federal certification test procedures are engine-based and therefore are not able to adequately represent the emissions benefits of the hybrid technology. Thus, diesel hybrid vehicle projects would only be approved on a case-by-case basis. ARB staff would determine the emissions benefits primarily based on the chassis Central

Business District Cycle. Additional information may be used based on the operating regime of the engine in the particular hybrid system. Alternative-fuel hybrid electric vehicles with engines certified to low-emission standards would be eligible for funding under the Carl Moyer Program.

c. Incentives for Early Replacement of Pre-1987 Heavy-Duty Vehicles

This section has been added to explain staff's preliminary analysis pertaining to providing incentives for the early replacement of pre-1987 heavy-duty vehicles. The new section reads as follows.

Pre-1987 heavy-duty diesel trucks still comprise a significant portion of the truck population in California. The engines in these trucks are continuing to be rebuilt since the truck owners/operators typically don not have the financial resources to buy newer trucks. These vehicles typically operate at California's ports, haul aggregate material in and out of densely populated areas. They also operate around-the-clock, and on a seasonal basis hauling agricultural products, as well as other non-line haul local deliver applications.

ARB staff understands the need to reduce emissions from this segment of the heavy-duty diesel truck sector. In fact, ARB considered a similar program to retire heavy-duty engines in the past. However it was a challenge to determine the remaining useful life of the old heavy-duty vehicle, and the emission benefits that could be achieved. Therefore, that program was never implemented. Staff conducted another analysis to determine potential benefits associated with providing incentives for the early replacement of pre-1987 heavy-duty engines. This analysis is provided in Appendix A. Based on the preliminary results of that analysis, staff was not able to develop a cost-effective program and is currently soliciting comments on how to incorporate a cost-effective program to replace pre-1987heavy-duty vehicles.

B. Project Criteria

ARB staff recommends that the project life be selected based on the remaining amount of useful life for the older engine. In an effort to normalize the project life selected for each project category, staff proposes the following new criteria to normalize the project life for on-road heavy-duty vehicle engine projects based on whether the project is for a new purchase, an alternative fuel engine purchase, or a repower.

- The acceptable project life for calculating on-road project benefits is as follows:

School buses $\geq$ 33,000 GVWR-- Natural gas (new/repower):	20 years.
Buses $\geq$ 33,000 GVWR -- Natural gas (new/repower) bus	12 years
Other On-road -- diesel-to-diesl repowers	5 years
Other On-road – Natural gas (new/repower) or New Diesel	10 years

C. Potential Types of Projects.

1. New Vehicles

Staff proposes Table II-2 be modified to include the most recent list of heavy-duty engines certified to ARB's Optional NOx Emission Credit Standards. The following table would replace the current Table II-2.

Table II-2
Heavy-Duty Engines Certified to
ARB's Optional NOx Emission Credit Standards
(Emission Levels for NOx, PM, and NMHC are in g/bhp-hr)

MY	Manuf.	Service Type[a]	Fuel Type	Displ (ltr)	NOx	PM	NMHC	Cert. Std. NOx/PM	HP
2000	Baytech	MHD	Dual[b]	5.7	1.3	--	0.00[c]	1.5/NA	211/245[d]
2000	Baytech	MHD	CNG	5.7	1.3	--	0.00	1.5/NA	211
2000	Baytech	HDG	CNG	5.7	1.3	--	0.00	1.5/NA	211
2000	Baytech	HDG	Dual[b]	5.7	1.3	--	0.00[c]	1.5/NA	211/245[d]
2000	Cummins	MHD	LPG	5.9	2.3	0.01	--	2.5/0.10	195
2000	Cummins	MHD	L/CNG	5.9	1.8	0.02	0.1	2.5/0.10	150/195/230
2000	Cummins	HHD	CNG	8.3	1.837	0.02	0.6	2.5/0.10	250/275
2000	Cummins	UB	CNG	8.3	1.7	0.02	0.6	2.5/0.05	250/275
2000	DDC	UB	L/CNG	12.7	2.0	0.02	0.8	2.5/0.05	330
2000	DDC	UB	L/CNG	8.5	1.5	0.01	0.8	2.0/0.05	275
2000	Deere	MHD	CNG	8.1	2.2	0.02	0.4	2.5/0.10	225/250
2000	Deere	MHD	CNG	6.8	2.4	0.04	0.3	2.5/0.10	225
2000	IMPCO	MHD	LPG	7.4	0.8	--	0.66	1.5/NA	229
2000	Mack	HHD	L/CNG	11.9	2.3	0.03	0.3	2.5/0.1	325/350
2000	PSA	MHHD	Dual[e]	7.2	2.2	0.08	1.2	2.5/0.10	200/240/250
2000	PSA	HHD	Dual[e]	10.3	2.4	0.06	1.1	2.5/0.10	305/350
2000	PSA	HHD	Dual[e]	12.0	2.4	0.10	0.5	2.5/0.10	370/410
1999	Deere	MHD	CNG	6.8	2.4	0.04	0.3	2.5/0.10	225
1999	Deere	MHD	CNG	8.1	2.2	0.02	0.4	2.5/0.10	250
1999	DDC	UB	CNG	12.7	2.0	0.02	0.8	2.5/0.05	330
1999	DDC	UB	CNG	8.5	2.2	0.01	0.6	2.5/0.05	275
1999	Cummins	UB	L/CNG	10.0	1.4	0.02	0.03	2.0/0.05	280/300
1999	Cummins	HHD	L/CNG	8.3	1.8	0.02	0.6	2.5/0.10	250/275
1999	Cummins	UB	L/CNG	8.3	1.7	0.01	0.2	2.5/0.05	250/275
1999	Cummins	MHD	L/CNG	5.9	1.8	0.02	0.1	2.5/0.10	150/195/230
1999	Cummins	MHD	LPG	5.9	2.3	0.01	0.8[f]	2.5/0.10	195
1999	IMPCO	MHD	LPG	7.4	0.8	--	0.66	1.5/N/A	229
1999	PSA[g]	MHD	Dual[e]	7.1	2.4	0.09	1.0	2.5/0.10	200
1999	PSA[g]	MHD	Dual[e]	7.2	2.2	0.07	1.2	2.5/0.10	250
1999	PSA[g]	MHD	Dual[e]	7.2	2.4	0.09	1.0	2.5/0.10	200
1999	PSA[g]	HHD	Dual[e]	10.3	2.4	0.06	1.1	2.5/0.10	305/350
1999	PSA[g]	HHD	Dual[e]	12.0	2.4	0.10	0.5	2.5/0.10	370/410

[a] Service Type: MHD (Medium Heavy-Duty); HHD (Heavy Heavy-Duty); UB (Urban Bus)
[b] Dual fuel (CNG or gasoline)
[c] NMHC: 0.00 for CNG; 0.2 for gasoline

[d] Horsepower: 211 for CNG; 245 for gasoline
[e] Dual Fuel (CNG + Diesel; or LNG + Diesel)
[g] Power Systems Associates (using Caterpillar engine)

2. Repowers

The following three paragraphs replace paragraph 2 in this section. Staff proposes this revision to explain ARB's current position with regard to mechanical-to-mechanical engine repowers, mechanical-to-electronic engine repowers, and electronic-to-electronic engine repowers. The new paragraphs read as follows:

For the purpose of the Carl Moyer Program, eligible heavy-duty diesel-to-diesel truck repower projects are those that replace pre-1987 model year mechanical engines with emission-certified 1987 to 1990 model year mechanical engines. Post 1987 repower projects are allowed for projects where a diesel engine is repowered with an alternative fuel engine. Diesel-to-diesel engine repowers for electronic-to-electronic engines are also allowed. The repower project, however, would be allowed only when replacing a 1988 and later model year electronic engine with an October 2002 and later model year engine.

Under the Carl Moyer Program, funding is not available for projects where gasoline engines (i.e. natural or gasoline) are replaced with new diesel engines. For urban and school buses, repowering projects are allowed for all model years but only for projects that replace the existing (diesel) engine in a bus with an alternative fuel engine. The replacement alternative fuel engine must be certified for sale in California to a NOx emission standard that is at least 30 percent lower than the original engine NOx certification level for the engine being replaced.

A few districts have expressed an interest to allow mechanical-to-electronic engine repowers for on-road heavy-duty engines. Although substantial NOx emissions may occur by repowering a pre-1987 mechanical engine with 2002 model year engines, the electronically controlled engines are difficult to install in applications that were not previously electronically controlled. The fuel system and electrical system for these engines is completely different compare to a mechanical engine. Hence, mechanical-to-electronic engine repowers would be allowed only on a case-by-case basis. ARB, in cooperation with the local air district, would evaluate the project and determine if the benefits are adequate to merit funding under the Carl Moyer Program.

3. Retrofits *No revisions.*

4. Sample Application

Staff proposes to replace Table II-3 with the following table. Additional criteria have been added to this table for consistency with all other project categories.

Table II-3
Minimum Application Information
On-road Projects

1. Air District
2. Project Funding Source: (Moyer or matching)
3. Applicant Demographics
   - Company Name:
   - Business Type:
   - Mailing Address:
   - Location Address:
   - Contact Number:
4. Project Description
   - Project Name:
   - Project Type:
   - Vehicle Function:
   - Vehicle Class:
   - GVWR(lbs):
5. NOx Reduction Incremental Cost Effectiveness Analysis Basis: (Mileage/Fuel/Hours of Operation)
6. VIN or Serial Number:
7. Application: (Repower, Retrofit or New)
8. Percent Operated in California:
9. Annual Diesel Gallons Used:
10. Annual Miles Traveled:
11. Hours of Operation:
12. Project Life (years):
13. Old Engine Information
    - Old Horsepower Rating:
    - Old Engine Make:
    - Old Engine Model:
    - Old Engine Year:
14. New Engine Information
    - New Horsepower Rating:
    - New Engine Make:
    - New Engine Model:
    - New Engine Year:
    - New Fuel Type:
15. NOX Emissions Reductions
    - Baseline NOx Emissions Standard (g/mi.):
    - NOx Conversion Factors Used:
    - LEV NOx Emissions Standard (g/mi.):
    - Estimated Annual NOx Emissions Reductions:
    - Estimated Lifetime NOx Emissions Reductions:
16. Cost ($) of the Base NOx Emissions Standard:
17. Cost ($) of Certified LEV NOx Emissions Standard:
18. PM Emissions Reductions
    - Baseline PM Emissions Standard (g/mi.):
    - PM Conversion Factors Used:
    - LEV PM Emissions Standard (g/mi.):
    - Estimated Annual PM Emissions Reductions:
    - Estimated Lifetime PM Emissions Reductions:
19. District Incentive Grant Amount:
20. Project Contact and/or Agreement:

D. Emission Reduction and Cost Effectiveness

1. Emission Reduction Calculation.

Staff proposes to replace the current section with the following paragraphs, except for the discussion pertaining to conversion factors as described in Appendix A. This section updates the emission factors to reflect EMFAC2000 and refines the emission reduction calculation methodology to be more accurate.

In general, the emission reduction benefit represents the difference in the emission level of a baseline and reduced-emission vehicle/engine. In situations where the model year of the vehicle chassis and the model year of the existing engine are different, the model year of the engine will be used to determine the baseline emission factor for emission reduction calculations. The emission level is calculated by multiplying an emission factor, conversion factor, and an activity level. Because the conversion factor and the activity level could be different for the baseline and reduced emission vehicle/engine, the emission level should be calculated first and then the difference taken to determine the emission reduction. The examples in the previous version, where the emission reductions were simply based on the difference in emission factors, assumed that there was no change in the conversion factor or activity level. For on-road vehicles, the activity level is defined by either the annual miles traveled or fuel consumed. Emission reduction calculations shall be consistent with the type of records maintained over the life of the project.

If the annual mileage is the basis for determining the emission reductions, the conversion factors listed in Table II-4 of Appendix A should be used and the activity level should be based on the vehicle odometer. If the annual fuel consumption is used, an energy consumption factor should be calculated and the activity level should be based on actual annual fuel receipts. The energy consumption factor converts the emission factor in terms of g/bhp-hr to g/gallon of fuel used. There are two ways of calculating the energy consumption factor: 1) divide the horsepower of the engine by the fuel economy in units of gallons/hour or 2) divide the density of the fuel by the brake-specific fuel consumption of the engine. While actual fuel receipts support the annual fuel consumption of the baseline engine, the annual fuel consumption of the reduced-emission engine is an estimate proportionate to the change in the energy consumption factor. For example, a reduced-emission engine having an energy consumption factor of 18.5, replacing a baseline engine which uses 5,000 gallons/year. and has an energy consumption factor of 17.8, would have an estimated annual fuel consumption of 5,197 gallons/year. Future fuel receipts should be submitted annually, throughout the project life, as verification of this estimate. The emission reductions will be updated, accordingly, at the final progress report to the Board. Lastly, if a project has an increase in horsepower greater than 25%, the emission reduction calculation shall be based on fuel consumption.

The NOx emission factors have been updated to reflect the recently adopted EMFAC2000 emissions model, which accounts for the settlement agreement between ARB and the diesel engine manufacturers (regarding excess NOx emissions from the use of alternative injection timing strategies). EMFAC2000 emission factors are based on chassis dynamometer test data that are in units of g/mile. The certification test data supplied by the engine manufacturer for the sale of a reduced emission engine are in terms of g/bhp-hr. Therefore, the EMFAC2000 emission factors were converted to g/bhp-hr by using the conversion factors listed in Table II-4 of Appendix A. The model year NOx emission factor listed in Tables II-5, II-6, and II-7 represent the zero mile emission factors of medium heavy-duty vehicles, heavy heavy-duty vehicles, and urban buses, respectively. School buses should use the emission factor and conversion factor according to their GVWR.

Based on discussion with engine manufacturers, neighborhood refuse collection trucks are subject to limited off-cycle emissions. ARB staff estimates that a typical heavy heavy-duty diesel truck performing neighborhood waste collection activities would have off-cycle emissions 20 percent of the time. Using a 4.0 g/bhp-hr NOx emission standard on the federal test procedure and a 6.0 g/bhp-hr NOx standard on the Euro III test procedure, ARB staff proposes that the base emission factor for this application is 4.4 g/bhp-hr.

Table II-5
Baseline NOx Emission factors for Medium Heavy-Duty Vehicles
14,001 – 33,000 lbs GVWR

Model Year	g/bhp-hr
Pre - 1984	8.0
1984 - 1986	7.8
1987 - 1990	6.8
1991 - 1993	5.7
1994 - 1997	5.0
1998 - 2002	4.6
2003	2.5
2004 - 2005	2.4

Table II-6
Baseline NOx Emission factors for Heavy Heavy-Duty Vehicles
33,000 + lbs GVWR

Model Year	g/bhp-hr
Pre – 1975	9.8
1975 – 1983	9.7
1984 – 1986	7.5
1987 – 1990	6.2
1991 – 1993	5.9
1994 – 1997	7.3
1998	8.9
1999 – 2002	5.1
2003 – 2005	2.6

Table II-7
Baseline NOx Emission factors forUrban Buses

Model Year	g/bhp-hr
Pre-1987	10.7
1987 – 1990	9.3
1991 – 1993	5.9
1994 – 1995	6.9
1996 – 1998	9.1
1999 – 2002	4.7
2003	2.4
2004 - 2005	0.6

2. Cost-Effectiveness Calculations

For clarification purposes only, ARB staff is adding new language to explain that incremental cost is used to determine the amount of funds allowed for a transit bus under the Carl Moyer Program. The first paragraph of the current approved section will be replaced with the following two paragraphs.

For new heavy-duty vehicle purchase projects, only the incremental cost of purchasing a new vehicle that meets the optional NOx emission credit standard compared to a conventional vehicle that meets the existing NOx emission standard, will be funded through the Carl Moyer Program. For vehicle repower projects, the portion of the cost for a vehicle repower project to be funded through the Carl Moyer Program is the difference between the total cost of purchasing and installing the new, emission-certified engine and the total cost of rebuilding the existing engine. For engine retrofit projects, the full cost of the retrofit kit will be funded subject to the $12,000 per ton cost-effectiveness criterion. For Urban Transit Buses, the portion of the capital cost to be funded through the Carl Moyer Program is the difference between non-FTA funds (20 percent of full capital cost) subject to the $12,000 per ton cost-effectiveness.

Full incremental cost for an urban transit bus would be granted, however, on a case-by-case basis. The transit district must demonstrate a true need. The transit district would need to provide ARB and the local air district with documentation demonstrating the transit agencies funding allocation (including source of funding); adopted procurement schedule; historical bus replacement data; types of alternative fuel buses they want to buy (including cost); and the number and cost of diesel fuel buses they would buy in lieu of the alternative fuel bus. The costs that are not considered eligible for Carl Moyer funds include operating costs such as maintenance costs, or other "life-cycle" costs.

3. Examples

Staff proposes to add the following two new examples to illustrate the revisions in the emission reduction calculations.

Example 1 – Diesel to Diesel On-Road Repower (Calculations based on Mileage). A line haul trucking company proposes to repower a 1986 diesel line haul truck with a model year 2000 certified low NOx diesel engine. This vehicle operates 90% of the time in California.

<u>Emission Reduction Calculation</u>

Annual NOx Reductions (tons/year) =

[(NOx Emission factor * Conversion Factor) $_{\textbf{baseline}}$ **- (NOx Emission factor * Conversion Factor)** $_{\textbf{reduced}}$**] * Annual Miles Traveled * % Operated in CA * ton/907,200 g**

Where,

Baseline NOx Emission factor:	7.5 g/bhp-hr
Baseline Conversion Factor:	2.7 bhp-hr/mile
Reduced NOx Emission factor:	5.1 g/bhp-hr
Reduced Conversion Factor:	2.6 bhp-hr/mile
Annual Miles:	60,000 miles
% Operated in CA:	90%
Convert grams to tons:	ton/907,200g

Hence, the estimated reductions are:

[(7.5 g/bhp-hr * 2.7 bhp-hr/mi.) – (5.1 g/bhp-hr * 2.6 bhp-hr/mi.)] * 60,000 mi/year * 90% * ton/907,200 g = **0.42 tons/year NOx emissions reduced**

Example 2 – CNG New Vehicle Purchase (Calculations Based on Fuel Consumption). A refuse collection company proposes to purchase a new CNG vehicle versus a diesel one with a GVWR 58,000 lbs. This vehicle operates 100% of the time in California.

<u>Emission Reduction Calculation</u>

Annual NOx Reductions (tons/year) =

[(NOx Emission factor * Energy Consumption Factor * Annual Fuel Consumption)$_{\text{baseline}}$ - (NOx Emission factor * Energy Consumption Factor * Annual Fuel Consumption)$_{\text{reduced}}$] * % Operated in CA * ton/907,200 g

Where,

Baseline NOx Emission factor:	5.1 g/bhp-hr
Reduced NOx Emission factor:	2.5 g/bhp-hr
Conversion Factor:	18.5 bhp-hr/gal
Annual Fuel Consumption:	10,400 gal/year
% Operated in CA:	100 %
Convert grams to tons:	ton/907,200 g

Hence, the estimated reductions are:

(5.1 g/bhp-hr – 2.5 g/bhp-hr) * 18.5 bhp-hr/gal * 10,400 gal/year * 100% * ton/907,200 g =
0.55 tons/year NOx emissions reduced

E. Reporting and Monitoring *No revisions.*

CHAPTER III.

OFF-ROAD EQUIPMENT

A. Introduction

1. Emission Standards

This section was updated to reflect the recently adopted emissions inventory for off-road large compression-ignited engines, greater than or equal to 25 horsepower. The OFFROAD model incorporated recent data and reflects currently adopted regulations. Manufacturers applied some of the technology advancements in the fuel management systems used in 1988 and newer on-road diesel-powered engine to similar off-road engines. Staff proposes to replace the existing Table III-6 with the table below.

Table III-6
Baseline NOx Emission factors for
Uncontrolled Off-Road Heavy-Duty Diesel Engines
(g/bhp-hr)

Model Year	50 –120 hp	120 + hp
Pre - 1988	13	11
1988 – 1996 *	8.75	8.17

2. Control Technologies *No revisions.*

B. Project Criteria

ARB staff proposes to revise the second criteria of this section under the current guidelines to require that for equipment repower projects, a new engine must be certified to the existing emission standard. Staff also proposes to add new criteria normalizing the project life for off-road engines. The criteria read as follows:

- For equipment repower projects: (I) the new engine must be certified to the existing NOx emission standard, or lower, if it is replacing an eligible uncontrolled engine, or (ii) the new engine must be certified to an optional NOx emission credit standard that is at least 30 percent lower than the existing NOx emission standard if it is replacing an eligible emission certified engine;

- The acceptable maximum project life for calculating benefits from off-road projects is as follows:

Construction new or natural gas	10 years
Construction diesel-to-diesel repower	7 years
Other new or natural gas	10 years
Other diesel-to-diesel repower	5 years

C. Potential Types of Projects

1. Purchase of New Emission-Certified Engines *No revisions.*

2. Repower with Emission-Certified Engines

Staff proposes to revise this section to clarify that gasoline-to-diesel repowers may not be funded under the Carl Moyer Program. The intent of the program is to clean-up existing diesel engines, not introduce them. Staff also proposes to remove the repower cap for construction equipment. The current section is replaced by the following three paragraphs.

Purchases of new emission-certified engines to replace uncontrolled engines in existing equipment are expected to be the most common type of project for off-road diesel equipment under this program. Eligible off-road equipment repower projects refers to replacing an older uncontrolled engine with a newer engine <u>certified to</u> either the existing NOx emission standard or to an optional NOx emission credit standard for off-road diesel equipment.

Eligible off-road equipment repower projects also refer to replacing an emission certified engine with a newer engine <u>certified to</u> an optional NOx emission credit standard, which is at least 30 percent lower than the NOx standard of the engine being replaced. Another option, which may be possible for some situations, is to repower off-road diesel equipment with a new or rebuilt on-road engine certified to NOx emission standard of 6.0 or lower. In addition, ARB could grant, on a case-by-case basis, an experimental permit for a particular engine with certain technology to operate in California. Funding under the Carl Moyer program is not available to pay for projects where a spark-ignition engine (i.e. natural gas, gasoline, etc.) is replaced with a diesel engine.

Off-road equipment repower projects that replace an existing diesel engine with an eligible reduced-emission diesel engine (either off-road or on-road) are subject to a maximum grant amount awarded, based on the horsepower category of the engine. Table III-3 lists the maximum grant amount allowed for each horsepower category. Technology for diesel-to-diesel repowers is readily available and relatively inexpensive compared to alternative fuel technologies. In addition, with newer diesel engines, an equipment operator can expect more reliable operation and improved fuel economy compared to older diesel engines and less risks compared to alternative fuel engines. Because of these reasons, staff believes that the incentive amounts listed in Table III-3 are adequate to allow diesel-to-diesel repower participation in the Carl Moyer Program. Repowering engines in construction equipment would be exempt from these incentive limits listed in Table III-3. Repowering projects that replace an existing diesel engine with a reduced-emission alternative fuel engine are not subject to the maximum cost limits as listed in Table III-3. However, diesel-to-alternative fuel repowering projects would still be subject to the cost-effectiveness criterion of $12,000 per ton of NOx emissions reduced, as well as other criteria presented in this guideline.

3. Retrofits *No revisions*

4. **Sample Application**

Staff proposes to replace Table III-4 with the following table. Additional criteria have been added to this table for consistency with all other project categories. Table III-4 is updated as follows:

Table III-4
Minimum Application Information
Off-road Projects

1. Air District: 2. Project Funding Source: (Moyer or matching) 3. Applicant Demographics Company Name: Business Type: Mailing Address: Location Address: Contact Number: 4. Project Description Project Name: Project Type: Equipment Function: 5. NOx Reduction Incremental Cost Effectiveness Analysis Basis: (Mileage/Fuel/Annual Hours) 6. VIN or Serial Number: 7. Application: (Repower, Retrofit or New) 8. Percent Operated in California: 9. Annual Diesel Gallons Used: 10. Annual Miles Traveled: 11. Hours of Operation: 12. Project Life (years): 13. Old Engine Information Old Horsepower Rating: Old Engine Make: Old Engine Model: Old Engine Year:	14. New Engine Information New Horsepower Rating: New Engine Make: New Engine Model: New Engine Year: New Fuel Type: 15. NOX Emissions Reductions Baseline NOx Emissions Standard (g/mi.): NOx Conversion Factors Used: LEV NOx Emissions Standard (g/mi.): Estimated Annual NOx Emissions Reductions: Estimated Lifetime NOx Emissions Reductions: 16. Cost ($) of the Base NOx Emissions Standard: 17. Cost ($) of Certified LEV NOx Emissions Standard: 18. PM Emissions Reductions Baseline PM Emissions Standard (g/mi.): PM Conversion Factors Used: LEV PM Emissions Standard (g/mi.): Estimated Annual PM Emissions Reductions: Estimated Lifetime PM Emissions Reductions: 19. District Incentive Grant Amount: 20. Project Contact and/or Agreement:

D. Emission Reduction and Cost-Effectiveness

1. Emission Reduction Calculation

Staff proposes to replace the current section with the following paragraphs. The new section would clarify the methodology for calculating emissions. It explains how and when to calculate emissions based on hours of operation, or fuel consumption. The new section reads as follows:

In general, the emission reduction benefit represents the difference in the emission level of a baseline and reduced-emission engine. In situations where the model year of the equipment and the model year of the existing engine are different, the model year of the engine will be used to determine the baseline emission factor for emission reduction calculations. The emission level is calculated by multiplying an emission factor, a conversion factor and an activity level. Because the conversion factor and the activity level could be different for the baseline and reduced emission engine, the emission level should be calculated first and then the difference taken to determine the emission reduction. The examples in the previous version, where the emission reductions were simply based on the difference in emission factors, assumed that there was no change in the conversion factor or activity level. For off-road equipment, the activity level is either the annual hours of operation or fuel consumed. Emission reduction calculations shall be consistent with the type of records that will be maintained over the life of the project.

If the annual hours of operation are the basis for determining the emission reductions, the conversion factor is the horsepower of the engine multiplied by the load factor of the application and the activity level should be based on the actual hours of the equipment. The load factor is an indication of the amount of work done, on average, by an engine for a particular application, given as a fraction of the rated horsepower of the engine. The load factor is different for each application. If the actual load factor is known for an engine application, it should be used in calculating the emission reductions. If the load factor is not known, the default values provided in Table III-4 should be used. Another variable in determining the emission reductions is the number of hours that the equipment operates a year. If the equipment is not outfitted with an hour meter or the actual hours of equipment operation are not known, the default values provided in Table III-4 should be used in the emission reduction calculation. Table III-4 provides the conservative default values for off-road equipment in agricultural and construction applications, as estimated by the adopted version of the OFFROAD model. For agricultural applications, the operating hours can range from 90 to 790 hours per year and the load factor can vary between 0.43 and 0.78. For construction applications, operating hours can range from 535 to 1641 hours per year and the load factor can vary between 0.43 and 0.78.

If the annual fuel consumption is used, an energy consumption factor should be calculated and the activity level should be based on actual annual fuel receipts. The energy consumption factor converts the emission factor in terms of g/bhp-hr to g/gallon of fuel used. There are two ways of calculating the energy consumption factor: 1) by dividing the horsepower of the engine by the fuel economy in units of gallons/hour or 2) by dividing the density of the fuel by the brake-specific fuel consumption of the engine. While actual fuel receipts support the annual fuel consumption of the baseline engine, the annual fuel consumption of the reduced-emission engine is an estimate proportionate to the change in the energy fuel consumption factor. For example, a reduced-emission engine having an energy consumption factor of 20, replacing a baseline engine which uses 3,696 gallons/year. and has an energy consumption factor of 18.5, would have an estimated annual fuel consumption of 3,419 gallons/year. Future fuel receipts should be submitted, throughout the project life, as verification of this estimate. The emission reductions will be updated, accordingly, at the final progress report to the Board. Lastly, if a project has an increase in horsepower greater than 25%, the emission reduction calculation shall be based on fuel consumption.

Table III-4
Default Operating Hours and Load Factors for
Off-Road Agricultural and Construction Equipment
50+ Horsepower

	Agricultural	**Construction**
Operating Hours (hr/year)	90	535
Load Factor	0.43	0.43

2. Cost-Effectiveness Calculation *No revisions*

3. Examples

Staff proposes the following two new examples to explain the new emission reduction calculations.

Example 1 – Construction Equipment Repower (Calculations Based on Hours of Operation). An equipment owner applies for a Carl Moyer Program grant for the purchase of a new off-road diesel engine rated at 180 hp to replace a 1985 uncontrolled diesel engine rated at 150 hp used in a construction loader. The owner does not know the load factor for this application. Both the old and new engine will operate 700 hours annually and 100 percent of the time in California.

<u>Emission Reduction Calculation</u>

Annual NOx Reductions (tons/year) =
[(NOx Emission factor * Load Factor * Horsepower) $_{baseline}$ - (NOx Emission factor * Load Factor * Horsepower) $_{reduced}$] * Annual Hours of Operation * % Operated in CA * ton/907,200 g

Where,

Baseline NOx Emission factor:	11 g/bhp-hr
Reduced NOx Emission factor:	6.25 g/bhp-hr
Load Factor:	0.43
Baseline Horsepower:	150 hp
Reduced Horsepower:	180 hp
Annual Hours of Operation:	700 hours
% Operated in CA:	100%

Hence, the estimated reductions are:

[(11 g/bhp-hr * 0.43 * 150 hp) – (6.25 g/bhp-hr * 0.43 * 180 hp)] * 700 hrs/year * 100% * ton/907,200 g = **0.17 tons/year NOx emissions reduced**

Example 2 – Marine Auxiliary Engine Repower (Calculations Based on Fuel Consumption). A shipping company wants to replace a 1950 marine auxiliary engine rated at 131 horsepower consuming 6,400 gal/year. of diesel fuel with a new diesel engine rated at 140 horsepower. This ship operates 75% in California waters.

Emission Reduction Calculation

Annual NOx Reductions (tons/year) =

[(NOx Emission factor * Energy Consumption Factor * Annual Fuel Consumption)$_{baseline}$ - (NOx Emission factor * Energy Consumption Factor * Annual Fuel Consumption)$_{reduced}$] * % Operated in CA * ton/907,200 g

Where,

Baseline NOx Emission factor:	14 g/bhp-hr
Baseline Conversion Factor:	18 bhp-hr/gal
Baseline Annual Fuel Consumption:	6,400 gal/year
Reduced NOx Emission factor:	6.9 g/bhp-hr
Reduced Conversion Factor:	19 bhp-hr/gal
Reduced Annual Fuel Consumption:	6,063 gal/year
% Operated in CA:	75 %

Hence, the estimated reductions are:

[(14 g/bhp-hr * 18 bhp-hr/gal * 6,400 gal/year) – (6.9 g/bhp-hr * 19 bhp-hr/gal * 6,063 gal/year)] * 75% * ton/907,200 g = **0.68 tons/year NOx emissions reduced**

E. Reporting and Monitoring *No revisions.*

CHAPTER IV.

LOCOMOTIVES

A. Introduction *No revisions.*

B. Project Criteria

ARB staff recommends that the project life be selected based on the remaining amount of useful life for the older engine. In an effort to normalize the project life selected for each project category, staff proposes the following new criteria to normalize the project life for locomotive engine projects.

- The acceptable maximum project life for calculating project benefits are as follows:

A natural gas engine or new locomotive project	20 years
A repower or retrofit project	20 years.

C. Potential Types of Projects

1. Repowers *No revisions.*

3. **Retrofits** *No revisions.*

4. **Sample Project Application Forms**

Staff proposes to replace Table IV*-4 with the following table. Additional criteria have been added to this table for consistency with all other project categories.* Table IV*-4 is updated as follows:*

Table IV-4
Minimum Application Information
Locomotive Projects

1. Air District: 2. Project Funding Source: (Moyer or matching) 3. Applicant Demographics Company Name: Business Type: Mailing Address: Location Address: Contact Number:	4. Old Engine Information Old Horsepower Rating: Old Engine Make: Old Engine Model: Old Engine Year: 5. New Engine Information New Horsepower Rating: New Engine Make: New Engine Model: New Engine Year: New Fuel Type:

Table IV-4 (continued) Minimum Application Information Locomotive Projects	
6. Project Description Project Name: Locomotive Type: Engine Type: Vehicle Class: 7. NOx Reduction Incremental Cost Effectiveness Analysis Basis: (Mileage/Fuel/Hours of Operation) 8. VIN or Serial Number: 9. Application: (Repower, Retrofit or New) 10. Percent Operated in California: 11. Percent Operated in Air District: 12. Annual Diesel Gallons Used: 13. Fuel Consumption Rate: 14. Annual Ton-Miles: 15. Project Life (years):	16. NOX Emissions Reductions Baseline NOx Emissions Standard (g/mi.): NOx Conversion Factors Used: LEV NOx Emissions Standard (g/mi.): Estimated Annual NOx Emissions Reductions: Estimated Lifetime NOx Emissions Reductions: 17. Cost ($) of the Base NOx Emissions Standard: 18. Cost ($) of Certified LEV NOx Emissions Standard: 19. PM Emissions Reductions Baseline PM Emissions Standard (g/mi.): PM Conversion Factors Used: LEV PM Emissions Standard (g/mi.): Estimated Annual PM Emissions Reductions: Estimated Lifetime PM Emissions Reductions: 20. District Incentive Grant Amount: 21. Project Contact and/or Agreement:

D. Emission Reduction and Cost-Effectiveness *No revisions.*

E. Reporting and Monitoring *No revisions.*

F. References *No revisions.*

CHAPTER V.

MARINE VESSELS

A. Introduction *No revisions.*

B. Project Criteria

Staff proposes following two new criteria for marine vessel engines. First, staff proposes to normalize the project life selected for a marine vessel project by establishing a maximum allowable project life. Second staff proposes to establish a coastal boundary where emission benefits would be determined for marine vessel projects funded under the Carl Moyer Program. The proposed boundary was selected based on the results of the Tracer Study.

- The acceptable project life for calculating project benefits from marine vessels are as follows:

Fishing/Other Small Vessels – natural gas or new purchase	10 years
Fishing/Other Small Vessels – diesel-to-diesel repower	10 years
Ferries/Tugs/Large Vessels – natural gas or new purchase	20 years
Ferries/Tugs/Large Vessels – diesel-to-diesel repower	20 years

- Associated project benefits calculated for marine vessels funded under the Carl Moyer Program must be based on the amount of time a marine vessel operates within five miles of a district's shore.

C. Potential Types of Projects

1. Repowers & Retrofits *No revisions.*

2. Portside Equipment Repowers & Retrofits *No revisions.*

3. Sample Project Application Forms

Staff proposes to replace Table V-7 with the following table. Additional criteria have been added to this table for consistency with all other project categories. Table V-7 is updated as follows:

:

Table V-7
Minimum Application Information
Marine Vessel Projects

1. Air District:
2. Project Funding Source: (Moyer or matching)
3. Applicant Demographics
   - Company Name:
   - Business Type:
   - Mailing Address:
   - Location Address:
   - Contact Number:
4. Project Description
   - Project Name:
   - Vessel Type: (passenger ship, ferry, fishing boat, tug boat, etc.)
   - Propulsion Type:(motorship or steamship)
   - Engine Function:
   - Ship Service Speed:
   - Ship Deadweight Tonnage (DWT):
5. Avg. fuel consumption (gallons) per port call for each service mode
   - Cruise:
   - P-zone Cruise:
   - Maneuvering:
   - Hotelling:
6. Annual number of Port Calls in California:
7. Avg. time (hours) per port call in each service mode, and fuel consumption rate
   - Cruise:
   - P-zone Cruise:
   - Maneuvering:
   - Hotelling:
8. Ave. fuel consumption (gallons) per port call for Auxiliary Power
   - a) Boilers (motorship)
   - b) Engines (motorship)
   - c) Main boilers (steamship)
9. Application: (Repower, Retrofit or New)
10. Percent Operated within 5 miles of shore:
11. Project Life (years):
12. Average Nautical Miles per port call within California coastal water boundary:
13. Old Engine Information
    - Old Horsepower Rating:
    - Old Engine Make:
    - Old Engine Model:
    - Old Engine Year:
14. New Engine Information
    - New Horsepower Rating:
    - New Engine Make:
    - New Engine Model:
    - New Engine Year:
    - New Fuel Type:
15. NOX Emissions Reductions
    - Baseline NOx Emissions Standard (g/mi.):
    - NOx Conversion Factors Used:
    - LEV NOx Emissions Standard (g/mi.):
    - Estimated Annual NOx Emissions Reductions:
    - Estimated Lifetime NOx Emissions Reductions:
16. Cost ($) of the Base NOx Emissions Standard:
17. Cost ($) of Certified LEV NOx Emissions Standard:
18. PM Emissions Reductions
    - Baseline PM Emissions Standard (g/mi.):
    - PM Conversion Factors Used:
    - LEV PM Emissions Standard (g/mi.):
    - Estimated Annual PM Emissions Reductions:
    - Estimated Lifetime PM Emissions Reductions:
19. District Incentive Grant Amount:
20. Project Contact and/or Agreement:

D. Emission Reductions and Cost-Effectiveness

1. Emission Reduction Calculation

Staff proposes to replace the third paragraph in this section to clarify the marine vessels that would be funded under the Carl Moyer Program, based on results from the Southern California Ozone Study. The new paragraph reads as follows:

There is a degree of uncertainty regarding the amount of offshore emissions that actually reach the mainland. The Southern California Ozone Study (the Tracer Dispersion Study) was conducted and completed by ARB to determine offshore impacts. Results from this study indicate that emission reductions from marine vessels would benefit ozone, PM, and toxic emissions that indeed reach the mainland. However, due to the uncertainty on the actual quantities of emissions reaching the mainland, emission benefits from marine vessel projects would be calculated based emissions that occur within a district's inventory boundary.

2. Cost-Effectiveness Calculation *No revisions.*

3. Examples *No revisions.*

E. Reporting and Monitoring *No revisions* .

F. References *No revisions.*

CHAPTER VI.

STATIONARY AGRICULTURAL ENGINES

The first sentence of the introductory paragraph in this chapter was modified to clarify that a stationary agricultural pump engine is considered to be an agricultural irrigation pump engine. The proposed modification reads as follows:

This chapter presents the project criteria under the Carl Moyer Program for stationary agricultural irrigation pump engines (stationary agricultural pump engines).

A. Introduction

The following paragraphs would replace the first two paragraphs in this section. Staff proposes these revisions to clarify the reasons for allowing certified off-road engines to be used in stationary agricultural pump engine repower projects. The revisions also explain how the off-road emission standards would apply to stationary agricultural pump engines that are funded through the Carl Moyer Program. The proposed new section reads as follows:

Stationary internal combustion engines used for agricultural purposes in California are primarily utilized to power irrigation water pumps. For the purposes of the Carl Moyer Program, these engines could be considered part of off-road equipment, because off-road engines are often utilized in stationary agricultural applications. However due to the operating characteristics specific to stationary agricultural pump engines, they are evaluated separately from the off-road equipment category, which generally covers mobile equipment such as agricultural tractors, backhoes, excavators, trenchers, and motor graders.

Off-road engines can be divided into two major categories: (1) engines less than (<) 175 brake horsepower (bhp) and (2) engines greater than or equal to ($\geq$) 175 bhp. The federal Clean Air Act Amendments (CAAA) of 1990 gave the United States Environmental Protection Agency (U.S. EPA) exclusive authority to regulate new off-road engines. The amendments created a federal preemption that prevents states from adopting emissions standards or other requirements for off-road engines [CAA, section 209(e)]. However, Congress allowed California, upon receiving authorization from the U.S. EPA, to adopt standards and regulations for preempted engines, with the exception of new farm and construction engines <175 bhp. In other words, the ARB does not have authority to regulate off-road engines <175 bhp used in farm operations. Also, the California Health and Safety Code (HSC) section 42310(e) prohibits local air districts or the State from requiring a permit for farm equipment.

According to federal definition, off-road engines do not include engines used in off-road applications, which are considered stationary. Off-road engines, however, are a workable option for stationary agricultural applications. Therefore, for the purposes of the Carl Moyer Program, staff recommends that the guideline criteria for stationary agricultural pump engines be established within the framework of applying ARB/U.S. EPA off-road engine emissions standards to stationary agricultural pump engines. Under the Carl Moyer Program, funding will be provided for voluntary reduction of NOx emissions from stationary agricultural irrigation pumps with engines 50 horsepower or greater. Section B of this chapter discusses specific criteria that must be met in order to qualify for funding from the Carl Moyer Program for this source category.

1. Emission Inventory

Staff proposes to replace the current section with the following new paragraphs. In an attempt to standardize the project life of stationary agricultural pump engines, staff proposes these modifications to include a definition for an acceptable project life of an agricultural pump engine repower project. Other minor modifications include modifying the term internal combustion engine to include "fuel-fired". Lastly, a revision to state that ARB's estimated NOx emissions from agricultural irrigation pump engines are based on data provided by San Joaquin Unified and Santa Barbara County Air Pollution Control Districts is added. The proposed new section reads as follows:

Agricultural irrigation pumps are powered electrically and with <u>fuel-fired</u> internal combustion engines. A 1995 report written by Sonoma Technology, Inc. for the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) indicates 90 percent of irrigation pumps in the San Joaquin Valley are electrically powered. The remaining 10 percent are engine-driven pumps fueled most commonly with diesel and, to a lesser degree, with natural gas or propane. Diesel is most commonly used due to its lower cost and the limitations posed by inaccessibility to natural gas lines in certain rural areas. In general, stationary agricultural pump engines run an average of 10,000 hours before requiring an overhaul or rebuild. Depending on each engine owner's operating schedule and maintenance routine, this equates to a variety of engine lifetimes. Stationary agricultural pump engines generally have low annual operating hours, from 1,000 to 3,600 hours per year. Using this range of operating hours, an engine can run 3 to 10 years before rebuild. If an engine can be rebuilt 3 to 4 times, it is possible to get 30 to 40 years of life out of an engine. Once an engine has exhausted its useful life, the most common engine replacement practice by farmers is to purchase a rebuilt engine rather than a new engine. The acceptable project life for agricultural pump engine repowers under the Carl Moyer Program will be five to 10 years depending on if the project is for a diesel-to-diesel repower or an natural gas engine/electric motor.

Stationary agricultural pump engines can be considered a seasonal source of NOx emissions, although NOx emissions occur throughout the calendar year. Most NOx emissions occur throughout the spring and summer months during the primary crop growing period. In fact, seasonal NOx emissions from agricultural pump engines may be as high as 52 tons per day in the summer months throughout the San Joaquin Valley, according to a 1995 Sonoma Technology, Inc. report. According to the ARB's 1997 baseline NOx emission inventory for agricultural irrigation pumps powered by diesel engines, NOx emissions are 34 tons per day. ARB's estimated NOx emissions are based on data provided by San Joaquin Unified and Santa Barbara County Air

Pollution Control Districts. Future emissions are projected to remain the same through 2010.

2. Emission Standards

Staff proposes to revise the current section to reflect the recently adopted emissions inventory for off-road large compression-ignited engines, greater than or equal to 25 horsepower. The OFFROAD model incorporated recent data and reflects currently adopted regulations. Manufacturers applied some of the technology advancements in the fuel management systems used in 1988 and newer on-road diesel-powered engine to similar off-road engines. Emission reductions from this technology are also reflected in the new emission factors.

It is important to understand that under the current Carl Moyer Program, agricultural irrigation pump engine repowers were very popular, with emission reductions well below the 25 percent reduction requirement listed in AB 1571. Using the new emission factors proposed below to calculate emission reductions from 1988 through 1996 model year engines would result in reductions less than the 25 percent requirement. Currently, ARB does not have the authority to modify the 25 percent emission reduction requirement, since that emission reduction requirement is a legislative requirement. Hence some agricultural irrigation pump projects may not be funded using the proposed emission factors.

The third paragraph and Table VI-5 in the current guidelines would be replaced with the following paragraph and table below.

For repower or retrofit projects involving uncontrolled engines, the emission reduction benefit must be determined by subtracting the certified off-road NOx emission standard of the new engine from the uncontrolled baseline NOx emission factor of the existing engine. In absence of manufacturer “guaranteed” emission factors, Table VI-5 lists the default baseline NOx emission levels for pre-1996 model year diesel engine repower and retrofit projects to be used when determining the NOx emission difference between the existing engine and the replacement engine. The applicant also has the option of testing the baseline engine using an ARB approved test procedure to determine actual emissions.

Table VI-5
Baseline NOx Emission factors for
Uncontrolled Off-Road Heavy-Duty Diesel Engines
(g/bhp-hr)

Model Year	50 –120 hp	120 + hp
Pre - 1988	13	11
1988 – 1996 *	8.75	8.17

3. Control Strategies

a. Emission-Certified Engines

The paragraphs below would replace the second paragraph of this section. This proposed revision would clarify what types of engine repowers are allowed for agricultural irrigation pumps. The staff proposes to allow either emission-certified off-road compression-ignition or emission-certified off-road spark-ignition engines to be used when repowering an agricultural pump engine. The new paragraphs read as follows:

A viable and cost-effective way to reduce emissions from uncontrolled diesel engines is to substitute the engine (i.e., repower) with an emission-certified off-road compression-ignition or emission-certified off-road spark-ignition engine instead of rebuilding the existing engine to its original uncontrolled specifications. With the exception of off-road engines >750 bhp, emission-certified diesel engines are commercially available for off-road engines ≥50 bhp that are covered under this program. The appropriate engine size for an irrigation pump will depend on a number of factors such as water demand and the size of the irrigation pump.

ARB adopted exhaust emission standards for large, off-road spark-ignition engines on October 22, 1998, subject to 15-day notice of public availability of modified text. As proposed before the Air Resources Board, beginning in 2001, new off-road, large spark-ignition (LSI) engines will be subject to ARB off-road engine exhaust emission standards. The emission standards are applicable to non-preempted off-road spark-ignition engines >25 bhp. The U.S. EPA expects to propose comparable nationwide exhaust emission standards for this category of engines. The regulations require a certification process similar to that used for small off-road engines and heavy-duty off-road engines. The ARB regulations were approved recently and requirements will be phased-in over the next few years. Repowers with off-road spark-ignition engines would have to undergo applicable certification testing to verify emission levels. For purposes of the Carl Moyer Program, off-road spark-ignition engines would be required, at a minimum, to test to the off-road diesel emission standards for the applicable model year and horsepower rating.

b. Electric Motors

The paragraphs below replace the existing paragraphs to this section. These proposed revisions include an explanation for the lower use of electric motors over engines in agricultural irrigation pump applications. It also explains the higher capital costs associated with diesel to electric stationary agricultural irrigation pump repower projects. The new section reads as follows.

Another potentially cost-effective way to reduce emissions from uncontrolled engines is to replace the internal combustion engine with an electric motor instead of rebuilding the existing engine to its original uncontrolled specifications. Substituting an electric motor for an internal combustion engine on an agricultural irrigation pump significantly reduces emissions. Replacing an older electric motor for a newer electric motor on an agricultural irrigation pump does not reduce emissions. Irrigation pumps powered by electric motors are commercially available for various applications. In fact, 90 percent of current irrigation pumps are already powered by electric motors. Hence, the requirements for an electrification project to qualify for funding under the Carl Moyer Program are designed to target the replacement of the remaining 10 percent of internal combustion engines used in agricultural irrigation pumps. The viability of an electrification project will depend on a number of factors, including cost of electricity and proximity to an electric power grid. Replacement of uncontrolled engines with electric motors is not expected to be as frequent due to the higher capital costs associated with electrification projects.

c. Engine Retrofit Technology *No revisions.*

B. Project Criteria

The second, third, and fourth project criteria would be replaced by the project criteria listed below. The project criteria were modified to clarify the type of repowers and retrofits allowed for agricultural irrigation pump engine projects under the Carl Moyer Program. The proposed revised language allows for pre-1996 model year engines (50 through 750 horsepower) to be repowered with new off-road diesel engines certified to the current standard, new off-road spark-ignited engines that test at a NOx level that meets the current standard, or new electric motors. For these years, it also allows retrofit kits that are certified to the off-road emission standard for use on off-road engines. For 1996 and later model year engines, the repowered engine must be an engine certified to the off-road credit standards (for either diesel or spark-ignited engines), or an electric motor. Retrofit kits for 1996 and later model year engines must be certified to reduce NOx emissions by at least 25 percent. For 2000 and later model year engines greater than 750 horsepower the repowered engine must test to a NOx level 30 percent below uncontrolled baseline emissions. Finally, all engines must be tested using ARB test procedures for off-road engines.

Staff is also proposing a new project criteria to normalize the allowable project life for agricultural pump engine projects. The proposed new language reads as follows:

- A repower or retrofit of a pre-1996 model year engine greater than 50 and through 750 horsepower must be with:
  1) An new off-road diesel engine certified at the 6.9 g/bhp-hr NOx emission standard for off-road engines,
  2) A new off-road spark-ignited engine that tests at a NOx level that meets the off-road diesel engine standard (i.e., 6.9 g/bhp-hr),
  3) A new electric motor, or
  4) A kit that is certified to the off-road engine emission standards for use on off-road engines;

- A repower or retrofit of a pre-2000 model year off-road engine~~s~~ greater than 750 horsepower must test to a NOx level 30% below uncontrolled baseline emissions;

- A repower of an emission-certified off-road engine of model year~~s~~ 1996 and newer, must be with:
  1) A new off-road diesel engine certified at one of the applicable NOx emission credit standards listed in Table VI-2,
  2) A new off-road spark-ignition engine that tests at a NOx level that meets the off-road NOx emission credit standards, or
  3) A new electric motor;

- A retrofit of an emission-certified off-road engine of model year 1996 and newer, must be certified to reduce NOx emissions by at least 25% for use in off-road engines;

- Engines must be tested using ARB test procedures for off-road engines;

- The maximum life for a new purchase or natural gas agricultural pump project is 16 years. The maximum life for a repower or rebuilt agricultural pump project is five years.

C. Potential Types of Projects

The following sentence replaces the second to the last sentence of the paragraph. The proposed revisions includes the term "diesel" to specify that only diesel repower projects are subject to a maximum grant dollar amount based on the engine's horsepower. Agricultural pumps repowered with natural gas engines or electric motors are not subject to the maximum grant dollar amounts based on engine horsepower. The proposed new sentence reads as follows.

In addition, diesel repower projects are also subject to a maximum dollar amount to be granted based on the horsepower rating of the engine.

1. Repower with Emission-Certified Engines

Staff proposes to replace paragraphs 1 and 2 in the current section with the following three paragraphs. These new paragraphs explains staffs proposal to allow funding to repower uncontrolled agricultural pump diesel engines with new off-road spark-ignition engines. Language has also been added to emphasize that gasoline-to-diesel repower projects do not qualify for funding. The major revision to this section is the language in the new paragraph for this section. Staff proposes to allow the large spark-ignition engines to be tested, in lieu of certification since a number of these engines have not gone through certification testing. Testing will be conducted according to ARB test procedures for off-road engines. Paragraphs 1,2 and 4 read as follows:

Purchases of new emission-certified diesel off-road engines to repower uncontrolled diesel engines are expected to be the most common type of project for stationary agricultural pump engines under this program due to their wide availability. Several air districts are currently funding these projects. Purchases of new off-road spark-ignition engines to repower uncontrolled diesel engines are also an option under this program.

Under the Carl Moyer Program, a stationary agricultural pump engine repower is substituting an existing uncontrolled engine with a new off-road engine certified to a current off-road NOx emission standard, or substituting an existing certified off-road engine with a new off-road engine certified to an optional ARB NOx emission credit standard. The NOx level that would qualify a stationary agricultural pump engine repower project for funding would depend on the engine model year and the engine size, as outlined in the criteria under section B and listed in Table VI-2. For repower projects, gasoline to diesel repowers will not qualify for the Carl Moyer Program.

Technology for “diesel-to-gaseous” fuel repowers is available; however an extensive number of spark-ignition engines have not gone through certification testing. The new ARB LSI regulations establish a testing program, and future U.S. EPA regulations will establish a similar testing procedure. Off-road spark-ignition engines used for repowers, would have to be tested according to ARB test procedures for off-road engines. Carl Moyer Program funds will not cover the costs of certification testing. These costs will have to be absorbed by the applicant, engine manufacturer, or another outside source. Projects that repower an existing diesel engine with a reduced-emission alternative fuel off-road engine are not subject to the maximum cost limits as listed in Table VI-3. However, diesel-to-alternative fuel repowering projects would still be subject to the cost-effectiveness criterion of $12,000 per ton of NOx emissions reduced, as well as other criteria presented in this guideline.

2. Replacement with Electric Motors

Staff proposes the following new section to provide more information and criteria specific to electric motors used in agricultural pump applications. The remaining sections have been renumbered accordingly.

Replacement of uncontrolled engines with electric motors is an option under the Carl Moyer Program. During the first year of the program, applications for electric motors were scarce. This was partly due to exclusion of infrastructure costs in determining the funding amount, which resulted in higher initial out-of-pocket costs to the applicant. In an electric pumping application, peripheral equipment is needed to supply electricity to the motor. The installed cost of a new certified diesel engine is comparable to the installed cost for an electric motor plus its necessary supporting components. Districts and utility companies have indicated that many diesel pump engines are situated next to existing electric lines, so no line extension would be needed. Considering the air quality benefits of electric motors, selected infrastructure costs for necessary equipment associated with the motor (e.g., control panel, motor leads, service pole with guy wire, connecting electric line) may be included in determining the grant amount awarded.

For more remotely located irrigation pumps, some utility companies offer monetary line extension credits. Where a credit applies, the customer is responsible for the cost of the line extension (generally charged on a per foot basis) beyond what is covered by the credit. In most cases, costs associated with electric line extensions may not be covered with Moyer funds. The only instance where Moyer funds may be used toward line extensions is where the maximum amount to be funded does not exceed the applicable Table VI-3 funding cap for a diesel-to-diesel repower. In these cases, the balance of funds up to the Table VI-3 grant limits may be applied toward a line extension, provided these funds come from district funds and are counted as matching funds. This may only be applied where the applicant faces out-of-pocket expense above the line extension credit allowance (i.e., the needed line footage is outside the maximum distance provided free of charge).

Projects that repower an existing diesel engine with an electric motor are not subject to the maximum cost limits as listed in Table VI-3. However, diesel-to-electric motor repowering projects would still be subject to the cost-effectiveness criterion of $12,000 per ton of NOx emissions reduced, as well as other criteria presented in this guideline.

3. Retrofits

This section has been renumbered to accommodate the previous new section. In addition, the following sentence replaces the last sentence in this section. The proposed revision would clarify that a retrofit kit used in this application can be certified to less than 6.9 g/bhp-hr NOx emission standard. Previously the statement only indicates that it must be certified to 6.9 g/bhp-hr. Now it is clear than an engine certified lower will qualify as well. The proposed language reads as follows:

To qualify for funding for this type of project, the engine retrofit kit for uncontrolled engines must be certified to 6.9 g/bhp-hr NOx emission standard or less, for use in off-road engine applications.

4. Sample Application

Staff proposes to replace Table VI-4 with the following table. Additional criteria have been added to this table for consistency with all other project categories. Table VI-4 is updated as follows:

Table VI-4
Minimum Application Information
Stationary Agricultural Pump Projects

1. Air District:
2. Project Funding Source: (Moyer or matching)
3. Applicant Demographics
   - Company Name:
   - Business Type:
   - Mailing Address:
   - Location Address:
   - Contact Number:
4. Project Description
   - Project Name:
   - Project Type:
   - Equipment Function:
5. NOx Reduction Incremental Cost Effectiveness Analysis Basis: (Mileage/Fuel/Hours of Operation)
6. VIN or Serial Number:
7. Application: (Repower, Retrofit or New)
8. Percent Operated in California:
9. Annual Diesel Gallons Used:
10. Hours of Operation:
11. Project Life (years):
12. Old Engine Information
    - Old Horsepower Rating:
    - Old Engine Make:
    - Old Engine Model:
13. Old Engine Year:
14. New Engine Information
    - New Horsepower Rating:
    - New Engine Make:
    - New Engine Model:
    - New Engine Year:
    - New Fuel Type:
15. NOX Emissions Reductions
    - Baseline NOx Emissions Standard (g/mi.):
    - NOx Conversion Factors Used:
    - LEV NOx Emissions Standard (g/mi.):
    - Estimated Annual NOx Emissions Reductions:
    - Estimated Lifetime NOx Emissions Reductions:
16. Cost ($) of the Base NOx Emissions Standard:
17. Cost ($) of Certified LEV NOx Emissions Standard:
18. PM Emissions Reductions
    - Baseline PM Emissions Standard (g/mi.):
    - PM Conversion Factors Used:
    - LEV PM Emissions Standard (g/mi.):
    - Estimated Annual PM Emissions Reductions:
    - Estimated Lifetime PM Emissions Reductions:
19. District Incentive Grant Amount:
20. Project Contact and/or Agreement:

D. Emission Reduction and Cost-Effectiveness

1. Emission Reduction Calculation

Staff proposes to replace the current section with the following paragraphs. The engine default load factor is changed from 0.75 to 0.65, consistent with January 2000 revisions to California's Emissions Inventory for Off-Road Large Compression-Ignited Engines (>25hp).

In general, the emission reduction benefit represents the difference in the emission level of a baseline and reduced-emission engine. In situations where the model year of the equipment and the model year of the existing engine are different, the model year of the engine will be used to determine the baseline emission factor for emission reduction calculations. The emission level is calculated by multiplying an emission factor, a conversion factor and an activity level. Because the conversion factor and the activity level could be different for the baseline and reduced emission engine, the emission level should be calculated first and then the difference taken to determine the emission reduction. The examples in the previous version, where the emission reductions were simply based on the difference in emission factors, assumed that there was no change in the conversion factor or activity level. For a stationary agricultural irrigation pump, the activity level is either the annual hours of operation or fuel consumed. Emission reduction calculations shall be consistent with the type of records that will be maintained over the life of the project.

If the annual hours of operation are the basis for determining the emission reductions, the conversion factor is the horsepower of the engine multiplied by the load factor of the application and the activity level should be based on the actual hours of the equipment. The load factor is an indication of the amount of work done, on average, by an engine for a particular application, given as a fraction of the rated horsepower of the engine. The load factor is different for each application. If the actual load factor is known for an engine application, it should be used in calculating the emission reductions. Another variable in determining the emission reductions is the number of hours that the equipment operates a year as counted by an hour meter. If the load factor or operating hours not known, the default values provided in Table VI-5 should be used in the emission reduction calculation. These default values are based on agricultural irrigation pumps as represented in the adopted version of the OFFROAD model.

If the annual fuel consumption is used, an energy consumption factor should be calculated and the activity level should be based on actual annual fuel receipts. The energy consumption factor converts the emission factor in terms of g/bhp-hr to g/gallon of fuel used. There are two ways of calculating the energy consumption factor: 1) by dividing the horsepower of the engine by the fuel economy in units of gallons/hour or 2) by dividing the density of the fuel by the brake-specific fuel consumption of the engine. While actual fuel receipts support the annual fuel consumption of the baseline engine, the annual fuel consumption of the reduced-emission engine is an estimate proportionate to the change in the energy fuel consumption factor. For example, a reduced-emission engine having an energy consumption factor of 20, replacing a baseline engine which uses 3,696 gallons/year and has an energy consumption factor of 18.5, would have an estimated annual fuel consumption of 3,419 gallons/year. Future fuel receipts should be submitted, throughout the project life, as verification of this estimate. The emission reductions will be updated, accordingly, at the final progress report to the Board. Lastly, if the project has an increase in horsepower greater than 25%, the emission reduction calculation shall be based on fuel consumption.

Table VI-5 Operating Hours and Load Factors for Stationary Agricultural Irrigation Pumps 50+ Horsepower	
Operating Hours (hr/year)	749
Load Factor	0.65

2. Cost-Effectiveness Calculation No revisions.

3. Examples

Staff proposes to add a fourth example to illustrate the calculations associated with NOx reductions, PM reductions and cost effectiveness. The new example reads as follows:

Example 4 – Agricultural Irrigation Pump "Diesel-to-Natural Gas" Repower: The following example was added to illustrate the cost effectiveness calculations for a diesel-to-natural gas engine repower project.

Consider a farmer faced with the opportunity to replace a model year 1980 diesel engine rated at 165 hp used to power an irrigation water pump. The farmer is replacing the old uncontrolled engine (11 g/bhp-hr NOx) with a new, optionally certified off-road natural gas engine rated at 150 hp (4.5 g/bhp-hr NOx) during the normal rebuild period. In this case, the cost of the new, emission-certified off-road natural gas engine is $23,500 whereas the cost to purchase a rebuilt diesel engine would be $5,500. The cost of a non-resettable hour meter is $300. The new engine will operate 2,000 hours annually, for a project life of five years. The emission reduction and cost effectiveness for this project are calculated as follows:

<u>Emission Reduction Calculation</u>

Annual NOx Reductions (tons/year) =
[(NOx Emissions * Horsepower) $_{\text{baseline}}$ - (NOx Emissions * Horsepower) $_{\text{reduced}}$] * Load Factor * Annual Operating Hours * ton/907,200 grams

Where,

Baseline NOx Emissions: 11.0 g/bhp-hr
Baseline NOx Emissions: 165 horsepower
Reduced NOx Emissions: 4.5 g/bhp-hr
Reduced Horsepower: 150 horsepower
Load Factor: 65%
Annual Operating Hours: 2,000 hours/year
Convert grams to tons: ton/907,200 grams

Hence, estimated annual NOx reductions are:

[(11.0 g/bhp-hr * 165 hp) – (4.5 g/bhp-hr * 150 hp)] * 0.65 * 2,000 hours/year * ton/907,200 g) = **1.6 tons/year**

<u>Cost and Cost-Effectiveness Calculations</u>

The annualized cost is based on the portion of incremental project costs funded by the Carl Moyer Program, the expected life of the project (five years at a minimum), and the interest rate (5 percent) used to amortize the project cost over the project life. The incremental capital cost to the operator for this purchase and the maximum amount that could be funded through the Carl Moyer Program fund are determined as follows:

Incremental Capital Cost	= $23,800 - $5,500 = $18,300
Max. Amount Funded	= $18,300
Capital Recovery	= $[(1 + 0.05)^5 (0.05)]/[(1 + 0.05)^5 – 1] = 0.23$
Annualized cost	= (0.23)($18,300) = $4,209/year
Cost-Effectiveness	= ($4,209/year)/(1.6 tons/year) = **$2,631/ton**

The project meets the cost-effectiveness limit of $12,000/ton NOx reduced. Because the project consists of a diesel-to-alternative fuel repower, it is not subject to the maximum incentive amounts for engine repowers. This project would qualify for the maximum amount of grant funds ($18,300).

E. Reporting and Monitoring

1. Reporting

Staff proposes to replace the first paragraph of this section with the following paragraph. The proposed language would clarify the district's authority and responsibility to monitor the projects throughout the period claimed as project life for the engine.

During the project life, the district has the authority to conduct periodic checks or solicit operating records from the applicant that has received Carl Moyer Program funds. This is to ensure that the engine is operated as stated in the program application. Hence, the applicant must maintain operating records and have them available to the district upon request. Records must be retained and updated throughout the project life and be made available to the district upon request. Annual records must contain, at a minimum, total actual hours operated, or estimated amount of fuel used. Where records of actual hours of operation are chosen, the engine must be equipped with a non-resettable hour meter. The cost of the hour meter shall be included in the capital cost of the engine for determining grant monies awarded. For electrification projects, the applicant must have documentation of payment to the local utility company for power installation.

2. Monitoring No revisions.

F. References No revisions.

CHAPTER VII.

FORKLIFTS

New chapter approved October 12, 1999

A. Forklift Equipment *No revisions*

B. Emission Inventory *No revisions*

C. Emission Standards *No revisions*

D. Electric Forklifts *No revisions*

E. Control Strategies *No revisions*

F. Project Criteria

Funding for electric forklifts has been provided via a demonstration project in the SCAQMD for the first two years of the Carl Moyer Program. Under this demonstration program, SCAQMD staff was successful at incentivizing electric forklift projects that would not likely have occurred without funding. In addition, the SCAQMD staff determined that it was appropriate to set a cost-effectiveness criterion of $3000 per ton of NOx reduced for forklift projects. ARB staff proposes the following new criteria to expand the forklift demonstration program statewide, with the cap in place.

ARB staff is also proposing the following new criteria to normalize the project life selected for forklift projects. The project life for a forklift project would be selected based on the remaining amount of useful life for the older engine.

- The maximum cost effectiveness for a forklift project under the demonstration program is $3,000 per ton of NOx reduced.

- The maximum allowable project life for a new electric forklift project is five years.

G. Demonstration Program *No Revisions*

H. Sample Application

Staff proposes to replace Table VII-4 with the following table. Additional criteria have been added to this table for consistency with all other project categories. Table VII-4 is updated as follows:

Table VII-4 Minimum Application Information Forklift Projects	
1. Air District: 2. Project Funding Source: (Moyer or matching) 3. Applicant Demographics Company Name: Business Type: Mailing Address: Location Address: Contact Number: 4. Project Description Project Name: Engine Function: VIN or Serial Number: Is the electric forklift replacing an older non-electric forklift, part of operation or facility, or facility expansion, or for a brand new facility operations Maximum rated life capacity (lbs) 5. Application: (Repower, Retrofit or New) 6. Annual Hours of Operation: 7. Percent Operated in California: 8. Project Life (years): 9. ICE Forklift Being Replaced (if an existing business) ICE Forklift Horsepower Rating: ICE Forklift Manufacturer: ICE Forklift Model: ICE Forklift Year: 10. New Engine Information New Horsepower Rating: New Engine Make: New Engine Model: New Engine Year: Manufacturer and model number of new forklift: Type of forklift purchases:	11. NOX Emissions Reductions Baseline NOx Emissions Standard (g/mi.): NOx Conversion Factor Used: LEV NOx Emissions Standard (g/mi.): Estimated Annual NOx Emissions Reductions: Estimated Lifetime NOx Emissions Reductions: 12. Does the applicant rent or lease forklifts to others? 13. Cost of forklift (including 1 battery pack) 14. Cost of charging equipment: 15. Cost ($) of the Base NOx Emissions Standard (non-electric): 16. Cost ($) of Certified LEV NOx Emissions Standard: 17. PM Emissions Reductions Baseline PM Emissions Standard (g/mi.): PM Conversion Factor Used: LEV PM Emissions Standard (g/mi.): Estimated Annual PM Emissions Reductions: Estimated Lifetime PM Emissions Reductions: 18. District Incentive Grant Amount: 19. Project Contact and/or Agreement:

I. Emission Reduction and Cost-Effectiveness *No revisions*

J. Reporting and Monitoring *No revisions.*

CHAPTER VIII.

AIRPORT GROUND SUPPORT EQUIPMENT

New chapter approved October 12, 1999

A. Introduction *No revisions*

B. Ground Support Equipment and Emissions *No revisions*

C. Emissions Standards *No revisions*

D. Control Strategies *No revisions*

E. General Project Criteria *No revisions*

F. Airport GSE Project Criteria

ARB staff proposes that the project life for GSE be selected based on the remaining years of useful life for the older engine. In an effort to normalize the project life selected for each GSE projects, staff proposes the following new criteria.

- The acceptable project life for calculating emission benefits from GSE projects is 5 years.
-

G. Sample Application

Staff proposes to replace Table VII-4 with the following table. Additional criteria have been added to this table for consistency with all other project categories. Table VIII-4 is updated as follows:

Table VIII – 4 **Minimum Application Information** **GSE Projects**	
1. Air District: 2. Project Funding Source: (Moyer or matching) 3. Applicant Demographics Company Name: Business Type: Mailing Address: Location Address: Contact Number: Equipment Operator: (airport, airline, equipment management company, other) 4. Project Description Project Name: Engine Function: VIN or Serial Number: Airport where equipment operated: Equipment Function: (replacement for an existing equipment, fleet expansion, other) 5. Application: (Repower, Retrofit or New) 6. Annual Hours of Operation: 7. Percent Operated in California: 8. Project Life (years): 9. Existing ICE Equipment Being Replaced (if an existing business) ICE Equipment Horsepower Rating: ICE Equipment Manufacturer: ICE Equipment Model: ICE Equipment Year: ICE Equipment Fuel Type	10. New Equipment Information New Equipment Horsepower Rating: New Equipment Make: New Equipment Model: New Equipment Year: New Equipment Manufacturer Type of New Equipment purchases Number of New Equipment purchased: 11. NOX Emissions Reductions Baseline NOx Emissions Standard (g/mi.): NOx Conversion Factor Used: LEV NOx Emissions Standard (g/mi.): Estimated Annual NOx Emissions Reductions: Estimated Lifetime NOx Emissions Reductions: 12. Cost of New Equipment (including 1 battery pack) 13. Cost ($) of the Base NOx Emissions Standard: 14. Cost ($) of Certified LEV NOx Emissions Standard: 15. PM Emissions Reductions Baseline PM Emissions Standard (g/mi.): PM Conversion Factor Used: LEV PM Emissions Standard (g/mi.): Estimated Annual PM Emissions Reductions: Estimated Lifetime PM Emissions Reductions: 16. District Incentive Grant Amount: 17. Project Contact and/or Agreement:

H. Emission Reduction and Cost-Effectiveness *No revisions*

I. Reporting and Monitoring *No revisions*

CHAPTER IX.

PARTICULATE MATTER BASELINES

ARB staff proposes to add this new chapter to describe the Particulate Matter (PM) baseline levels and calculation methodology. This chapter also contains a brief overview of available control technologies, the Advisory Board's established PM target and requirement, PM emissions reduction calculations, and examples for calculating PM emission reductions.

A. Introduction

Diesel PM is a serious public health concern. Diesel PM, like ozone, has been linked to a range of serious health problems including an increase in respiratory disease, lung damage, cancer, and premature death. Fine diesel particles are deposited deep in the lungs and can result in increased hospital admissions and emergency room visits; increased respiratory symptoms and disease; decreased lung function, particularly in children and individuals with asthma; alterations in lung tissue and respiratory tract defense mechanisms; and premature death. On August 27, 1998, after extensive scientific review and public hearing, the Air Resources Board (ARB) formally identified particulate emissions from diesel-fueled engines as a toxic air contaminant.

The Carl Moyer Program was originally designed to help California meet the NOx emission reductions in measure M4 in the 1994 SIP. Although the focus of the program is on NOx reductions, some of the technologies, such as electric motors and alternative fueled engines, funded under this program also reduce PM. Even without specific requirements to reduce PM, the Carl Moyer Program has achieved approximately 100 pounds per day of PM reductions from projects funded in its first year. Based on recent information regarding the risks associated with PM, however, it has become more critical to include PM reductions into the Carl Moyer Program.

1. Advisory Board Recommendations

Assembly Bill 1571 called for the Advisory Board to review the program and propose changes. The Advisory Board released their report to the Governor and Legislature on March 31, 2000. In their report, the Advisory Board recognized that diesel PM is a serious public health concern and PM reductions are necessary throughout California. Hence, the Advisory Board established a PM reduction target for the statewide program and a PM reduction requirement for areas that are designated as non-attainment for the federal PM standard. As a result of the established criteria, ARB staff proposes PM default baseline levels and calculation methodologies.

2. Emission Inventory

Statewide NOx and particulate matter less than 10 microns (PM_{10}) emissions from selected categories of heavy-duty engines are shown in Table IX-1. PM emissions statewide from mobile sources are about 120 tons per day (1996 inventory). Heavy-duty mobile source engines account for about 60 percent of PM mobile source emissions statewide. Light and medium-duty vehicles account for about 30 percent. Currently two districts, San Joaquin Valley and South Coast exceed federal PM ambient air quality standards. Most districts do not attain California's most stringent state PM standards, leaving millions of California's exposed to dangerous amounts of PM on a daily basis.

Table IX-1
Statewide Emissions from Selected Heavy-Duty Engine Categories

Source Category	Current PM	2010 PM_{10}
On-Road Heavy-Duty Vehicle [a]	37	14
Off-Road Equipment	22	26
Locomotive	3	3
Marine	10	12
Total	72	55

a) Emissions from gasoline and diesel trucks and buses. Emissions based on EMFAC7G model, corrected to account for 2004 standards and off-cycle emissions.

b) 1996 emissions from off-road equipment, including equipment less than 50 horsepower. The off-road equipment emissions inventory is currently being revised.1996 emissions.

3. Emission Standards

The model year PM emission factors listed in Tables IX-2, IX-3, and IX-4 represent the EMFAC2000 zero mile emission factors of diesel-powered medium heavy-duty vehicles, heavy heavy-duty vehicles, and urban buses, respectively. School buses and neighborhood refuse trucks should use the emission factors and conversion factors according to their GVWR. For alternative-fueled urban transit buses, however, existing in-use test data shows that PM in-use emissions are 30-50 percent lower for a natural gas bus certified to the proposed 0.03 g/bhp-hr PM standard than for a diesel bus engine certified to the proposed 0.01 g/bhp-hr PM standard. So, alternative-fueled urban transit buses should use 0.025 g/mile PM emission factor.

Table IX-5 provides model year emission factors from the adopted OFFROAD model by horsepower group. ARB staff proposes that these off-road emission factors should be used for stationary agricultural pumps and harbor vessels with medium speed diesel engines. ARB staff is currently evaluating U.S. EPA's emission test data to determine the appropriate PM emission factors for locomotives and ocean going vessels.

Table IX-2
Baseline Emission factors for Medium Heavy-Duty Vehicles
14,001 – 33,000 lbs GVWR

Model Year	g/bhp-hr
Pre - 1984	0.5
1984 - 1986	0.4
1987 - 1990	0.3
1991 - 1993	0.2
1994 - 2005	0.1

Table IX-3
Baseline PM Emission factors for Heavy Heavy-Duty Vehicles
33,000 + lbs GVWR

Model Year	g/bhp-hr
Pre – 1984	0.7
1984 – 1986	0.4
1987 – 1990	0.3
1991 – 1993	0.2
1994 – 2004	0.1

Table IX-4
Baseline PM Emission factors for Urban Buses

Model Year	g/bhp-hr
Pre-1996	0.3
1996 – 1998	0.4
1999 – 2002	0.1
2003 - 2005	0.0

Table IX-5
ARB Exhaust PM Emission factors for Heavy-Duty Off-Road Diesel Engines

Horsepower	Model Year	g/bhp-hr
50 - 120	Pre – 1988 1988 - 2003 2004 2005	0.84 0.69 0.39 0.29
121 - 175	Pre – 1970 1970 – 1971 1972 – 1987 1988 - 2002 2003 2004	0.77 0.66 0.55 0.38 0.24 0.19
176 - 250	Pre - 1970 1970 – 1971 1972 - 1987 1988 - 2002 2003 2004 2005	0.77 0.66 0.55 0.38 0.24 0.19 0.16
251 - 500	Pre - 1970 1970 – 1971 1972 – 1987 1988 -1995 1996 - 2000 2001 2002 - 2005	0.74 0.63 0.53 0.38 0.15 0.12 0.11
501 - 750	Pre – 1970 1970 – 1971 1972 – 1987 1988 – 1995 1996 – 2001 2002 2003 - 2005	0.74 0.63 0.53 0.38 0.15 0.12 0.11
751+	Pre - 1970 1970 – 1971 1972 – 1987 1988 – 1999 2000 - 2005	0.74 0.63 0.53 0.38 0.15

4. Control Technologies

This section discusses current PM retrofit control technologies. A retrofit involves a hardware modification to an existing engine to reduce its emissions from the standards to which it was originally certified.

A variety of catalysts and filters (traps) have been developed over the last five years. PM catalysts have a control efficiency of around 30% while filters can achieve over 90% PM reduction. These control efficiencies would increase if used in conjunction with very low sulfur fuel.

PM catalysts have the advantage of being devices that can be added fairly easily but are not as effective as filters. Filters, however, require some means of regeneration or cleaning off the collected PM. The most effective way is to burn it. Failure to burn off PM in time can plug the filter and stop the engine, while burning too much at one-time can overheat and damage the filter. In most applications, the diesel exhaust temperature is not hot enough to start a filter's regeneration cycle.

One of the technologies that manufacturers express as the solution to the diesel PM problem is a catalyst-based diesel particulate filter (DPF). This is a filter that burns off the particulate using a catalyst to induce ignition. The catalyst material can either be directly incorporated into the filter system, or can be added to the fuel as a fuel-borne catalyst. In several European countries, catalyst-based DPFs have been installed on more than 6,500 heavy-duty vehicles. In the United States, the application of catalyst-based DPFs is less prevalent, but several demonstration projects are underway. In California, diesel fueled school buses and tanker trucks have been retrofitted with catalyzed DPFs as part of a program to evaluate the effectiveness of a refiner's low-sulfur diesel formulation.

B. PM Target and Requirement

Through a public process, the Advisory Board established the following PM reduction target and requirement:

- A 25 percent PM emissions reduction target for all districts on a statewide program-basis, except for Serious PM nonattainment areas.

- A 25 percent PM emissions reduction requirement for designated Serious PM nonattainment. Non-attainment for the federal PM standard <u>must</u> reduce PM emissions by 25 percent district-wide (on a program basis, instead of a project-by-project basis). Currently, San Joaquin Valley Air Pollution Control District and South Coast Air Quality Management District are the only two districts affected by the proposed requirement.

Emission Reductions

The program cost-effectiveness will continue to be calculated based on the NOx reductions alone. ARB staff proposes PM emission reductions to be calculated similar to the NOx emission reductions. For example if a project uses its annual miles traveled to determine its NOx emissions reductions, then it must also use annual miles traveled as the basis for determining PM emission reductions. It is important to understand, however, that baseline uncontrolled PM emission levels and controlled emission levels for PM emissions will differ from NOx emission level. These factors are listed in tables IX-2 through IX-5 above. Overall program reductions will be considered when determining the whether or not the 25 percent target/requirement has been met.

1. **Emission Reduction Calculations**

Based on the criteria already established by the Advisory Board, ARB staff is proposing PM emission factors to calculate PM emission reductions from the program. ARB staff proposes PM reductions be calculated in the same manner as the NOx emission reductions. Depending on the methodology the guidelines specifies for a particular project; the same criteria would apply when calculating PM emissions. ARB staff will determine overall statewide and district compliance with the PM reduction goals and requirements. If the program falls short, ARB staff will propose modifications to the program to achieve the necessary requirements.

Tables IX-2 through IX-4 contain ARB's proposed PM exhaust emission standards for on-road heavy-duty engines. For simplification purposes, PM emission reductions will be expressed in pounds reduced. If conversion factors are necessary use those listed in Table II-4 of Appendix A. The project life is provided under the project criteria in each project category chapter.

2. **Examples**

Example 1: Diesel-to-Diesel On-Road Vehicle Repower (Calculations Based on Annual Miles Traveled). A line haul trucking company proposes to repower a model year 1986 truck with a certified low NOx emission diesel engine model year 2000. The truck travels 60,000 miles a year and has a GVWR of 35,000 pounds. The applicant used the vehicle's annual miles traveled to determine NOx emissions reductions, and hence, will also use annual miles traveled to calculate PM emissions reductions. The project life is 10 years.

Baseline PM Emissions:	0.4 g/bhp-hr
Baseline Conversion Factor:	2.7 bhp-hr/mile
Reduced PM Emissions:	0.1 g/bhp-hr
Reduced Conversion Factor:	2.6 bhp-hr/mile
Annual Miles Traveled:	60,000 miles
% Operated in CA:	100%
Convert grams to pounds:	lbs/454 g

Baseline Engine:
0.4 g/bhp-hr * 2.7 bhp-hr/mile * 60,000 miles * 100% * lbs/454 g = 143 lbs/year

Reduced Engine:
0.1 g/bhp-hr * 2.6 bhp-hr/mile * 60,000 miles * 100% * lbs/454 g = 34 lbs/year

Estimated Annual PM Reductions

143 lbs/year - 34 lbs/year = **109 lbs/year PM emissions reduced**

Example 2: On-Road Diesel-to-CNG Repower (Calculations Based on Annual Miles Traveled). Consider a transit company faced with the opportunity of replacing a fleet of diesel-fueled buses with CNG fueled buses. The applicant opts to use the annual miles traveled to determine its NOx emissions reductions. Hence, the vehicle's annual miles traveled will be used to determine the PM emissions reduced. The current heavy-duty diesel engine dates to 1991 and has a project life of 12 years.

Baseline PM Emissions:	0.3 g/bhp-hr
Reduced PM Emissions:	0.02 g/mile
Conversion Factor of old engine:	4.3 bhp-hr/mile
% Operated in CA:	100%
Annual Miles Traveled:	70,000 miles
Convert grams to pounds:	lbs/454 g

Baseline Engine:
0.3 g/bhp-hr * 4.3 bhp-hr/mile * 70,000 miles * 100% * lbs/454 g = 199 lbs/year

Reduced Engine:
0.025 g/mile * 70,000 miles * 100% * lbs/454 g = 4 lbs/year

Estimated Annual PM Reductions

199 lbs/year – 4 lbs/year = **195 lbs/year PM emissions reduced**

Example 3: Marine Vessel Diesel to Diesel Repower (Calculations Based on Annual Fuel Consumption). A tugboat operator, participating in the Carl Moyer Program, repowers the uncontrolled, 1400 horsepower diesel engine of a tugboat with a lower emitting 1400 horsepower engine. The applicant used the annual fuel consumption of 50,000 gallons/year to determine NOx emission reductions, and so will use annual fuel consumption to calculate PM reductions. This tugboat operates 100% of its activity within five miles of shore and the life of the project is 15 years.

Baseline PM Emissions:	0.74 g/bhp-hr
Reduced PM Emissions:	0.15 g/bhp-hr

Energy Consumption Factor: 18.5 bhp-hr/gal
Annual Fuel Consumption: 50,000 gal/year
% Operated in California: 100%
Convert grams to pounds: lbs/454 grams

Baseline Engine:
0.74 g/bhp-hr * 18.5 bhp-hr/gal * 50,000 gal/year * 100% * lbs/454 g = 1508 lbs year

Reduced Engine:
0.15 g/bhp-hr * 18.5 bhp-hr/gal * 50,000 gal/year * 100% * lbs/454 g = 306 lbs year

Estimated Annual PM Reductions

1508 lbs/year – 306 lbs/year = **1,202 lbs/year PM emissions reduced**

Example 4: Off-road Diesel-to-Diesel Repower (Calculations Based on Hours of Operation). A farmer applies for a Carl Moyer Program grant to repower a grape harvester's uncontrolled 1969 diesel engine with at lower NOx and PM emitting model year 2000 diesel engine. Both engines are rated at 195 horsepower. If the farmer used 700 annual hours of operation to determine the NOx emissions reductions, then she must also base her PM emission reduction calculation on hours of operation. The project life of the grape harvester is 10 years and it operates 100% in California.

Baseline PM Emissions: 0.77 g/bhp-hr
Reduced PM Emissions: 0.38 g/bhp-hr
Rated Horsepower: 195 hp
Load Factor: 0.65
Annual Operating Hours: 700 hrs
% Operated in California: 100%
Convert grams to pounds: lbs/454 g

Baseline Engine
0.77 g/bhp-hr * 195 hp * 0.65 700 hrs/year * 100% * lbs/454 g = 150 lbs/year

Reduced Engine
0.38 g/bhp-hr * 195 hp *0.65 * 700 hrs/year * 100% * lbs/454 g = 74 lbs/year

Estimated Annual PM Reductions

150 lbs/year - 74 lbs/year = **76 lbs/year PM emissions reduced**

* NOTE: For areas designated serious nonattainment for PM, ARB will calculate the PM emission reductions on a program-wide basis, not a project-to-project basis. Consider the four previous examples as constituting a local district program. These projects yield a total of 1584 lbs/year of PM reductions and 2000 lbs/year of baseline PM emissions. Such a program represents a 79 percent PM emission reduction and meets the 25 percent PM emission reduction requirement. For areas designated attainment for PM emissions, ARB will calculate the PM emissions reductions statewide and the 25 percent PM reduction is a target.

E. Reporting and Monitoring

Each project category chapter contains monitoring and reporting instructions. PM reporting requirements are included in the minimum information application table of each project category chapter.

APPENDIX A

PROGRAM ANALYSIS
INCENTIVES TO REPLACE PRE-1987 HEAVY-DUTY VEHICLE

PROGRAM ANALYSIS
INCENTIVES TO REPLACE PRE-1987 HEAVY-DUTY VEHICLE

A. Background

Pre-1987 heavy-duty diesel trucks still comprise a significant portion of the truck population in California. These vehicles typically operate at California's ports, haul aggregate material in and out of densely populated areas, operate around-the-clock, and on a seasonal basis, hauling agricultural products, as well as other non-line haul, local delivery applications. The engines in these trucks are continuing to be rebuilt since the truck owners/operators typically do not have the financial resources to buy newer trucks. Furthermore, in cases where it is financially feasible for the owner to buy a newer vehicle, there may not be a real economic reason for doing so since these trucks are usually employed in lower revenue service compared to line-haul or other applications.

According to the ARB's emission inventory model (EMFAC2000), pre-1987 heavy-duty diesel trucks still account for about 20 percent of the total heavy-duty diesel truck population statewide. This correlates to about 76,000 pre-1987 trucks still in use throughout California. While these older trucks typically drive fewer miles and make fewer trips than newer trucks, their emissions are still significant since these engines were subject to less stringent NOx emission standards and were uncontrolled relative to PM emissions. Figures A-1 and A-2 compare the population, miles traveled, and NOx and PM emissions for heavy-duty diesel trucks statewide, in increments of five model years.

B. 1994 Ozone SIP Measure M-7

There is a need to reduce emissions from this segment of the heavy-duty diesel truck sector, to reduce ozone and benefit the health of all Californians. The ARB, in fact, proposed a concept for accelerating the retirement of heavy-duty vehicles in its 1994 Ozone State Implementation Plan (SIP) as measure M-7. That measure envisioned the annual retirement (scrapping or removal) of about 1,600 of the oldest, highest emitting trucks in the South Coast Air Basin, beginning in 1999 and continuing through 2010.

FIGURE A-1
POPULATION AND VMT--STATEWIDE

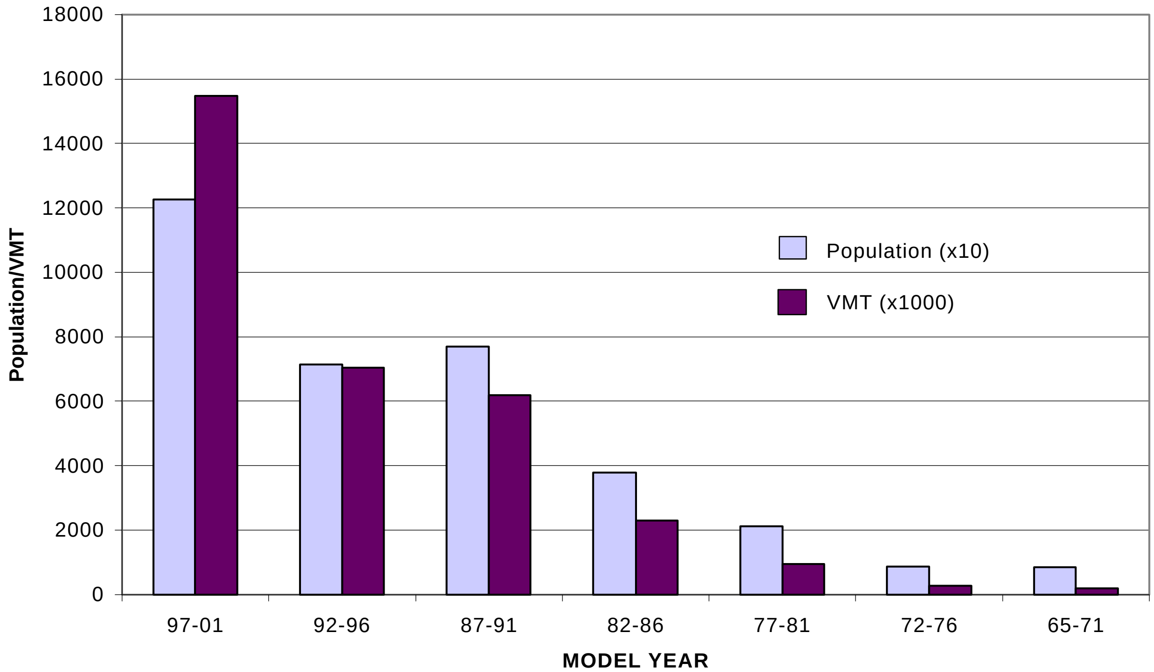
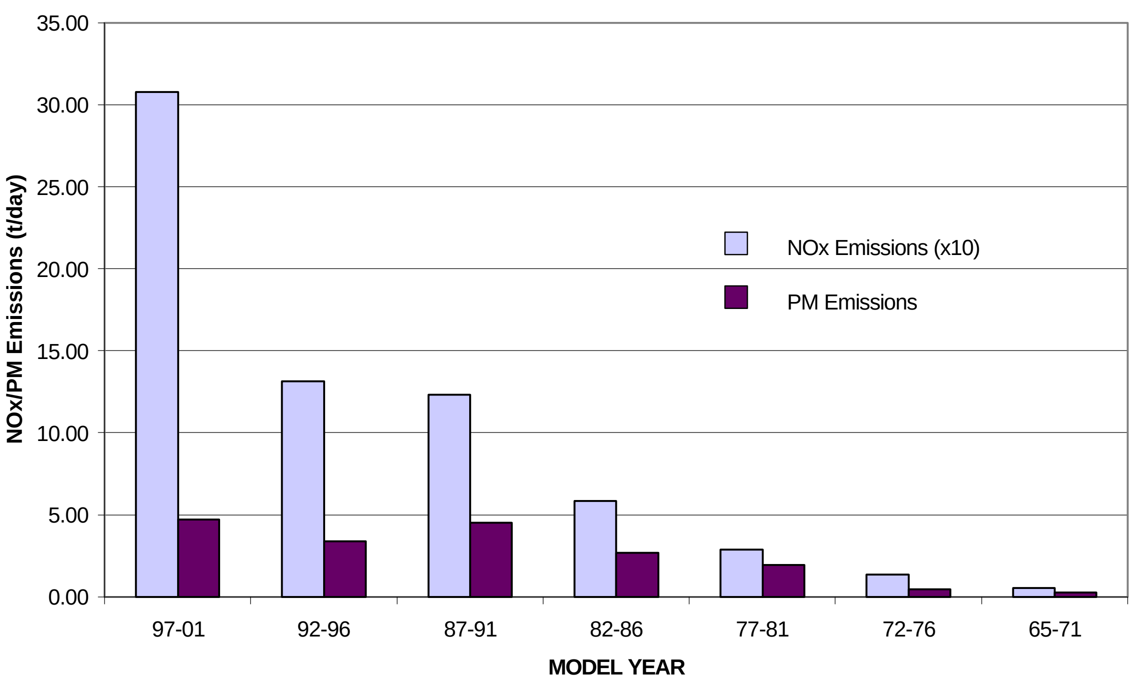


FIGURE A-2
NOx and PM EMISSIONS--STATEWIDE



At the time the 1994 ozone SIP was adopted, ARB staff anticipated that the retirement program could be self-sustaining through the sale of both the best old trucks (for export) and recovered parts from scrapped trucks. However, as ARB staff worked with the trucking industry and other stakeholders to develop this measure, it became clear that measure M-7 would not be able to deliver the emission reductions for two reasons -- lack of funding and expected emission benefits. The prospects for a self-funded program dimmed when the anticipated overseas market for old California trucks did not materialize and ARB better understood the value of these older vehicles to their owners. Analysis also indicates that the older, high emitting trucks removed from the fleet are not likely to be replaced with cleaner vehicles, but rather with trucks of similar age from outside the area, providing little or no emission benefit. Based on these concerns, M7 was withdrawn from the SIP.

C. Feasibility of Incentivizing the Early Replacemement of Pre-1987 Heavy-Duty Vehicles

Despite this challenge, ARB staff was directed by the Advisory Board to evaluate the feasibility of developing a heavy-duty vehicle retirement program within the framework of the Carl Moyer Program. Drawing from ARB's knowledge learned from SIP measure M-7, two critical factors must be addressed to ensure a successful heavy-duty vehicle retirement program. First ARB must determine adequate funding. Second, ARB staff must determine a method for quantifying emission reductions associated with such a program. Staff evaluated various options to achieve additional emission reductions from pre-1987 trucks, including truck repowering and incentivizing the early replacement of pre-1987 heavy-duty vehicles. Based on the preliminary results of that analysis, staff was not able to develop a cost-effective program. The data indicate that while some emission reductions may be achieved, these programs may not be feasible based on associated program cost-effectiveness and emission benefits. The sections below provide details pertaining to the results of ARB staff's analysis.

1. Pre-1987 Truck Repowering Option

Initially, repowering with electronic engines appears to be a very attractive and cost effective strategy for reducing emissions from pre-1987 heavy-duty diesel trucks. The emissions from these vehicles are higher compared to later model year vehicles. Pre-1987 heavy-duty diesel trucks were subject to a NOx emission standard of about 10 g/bhp-hr while PM emissions were uncontrolled and are assumed to be much greater than 0.6 g/bhp-hr, which is the PM standard effective with 1987 model year trucks. There may be a chance to reduce emissions from a small segment of these trucks by implementing a strategy that removes the older engines in these trucks and replaces them with later model year engine. In most of these trucks, however, a project would be economically unfeasible based on certain technical challenges due to significant differences in engine designs.

Pre-1987 heavy-duty diesel engines typically have the injection timing mechanically controlled instead of electronically controlled as are common in 1991 and later model year engines. In addition, pre-1987 engines generally have different power characteristics, especially the torque profile, compared to later model year engines. Repowering a pre-1987 mechanical engine to a later model year electronic engine would not be a simple engine swap, but would entail numerous details that must be addressed. Besides the intuitively expected installation of a new wiring harness to accommodate the increased presence of electronics, other engine and vehicle components, such as a new radiator to handle the increased engine heat, must be upgraded as well. In addition, the existing transmission and rear end of the truck would need to be examined to ensure that those components would be sufficiently robust to accept the increased power from the new engine. Because those components were originally designed to optimize performance with a different engine, and because of component deterioration associated with age, they may also need to be replaced. Even in cases where those components are deemed to be strong enough for the new engine, the gearing for the truck will likely need to be changed to better accommodate the new engine characteristics and to optimize any emission reduction benefits. The reason is that the existing vehicle gearing may be incorrectly matched to the engine output such that the engine cannot operate efficiently. This would result in poor performance and increased emissions.

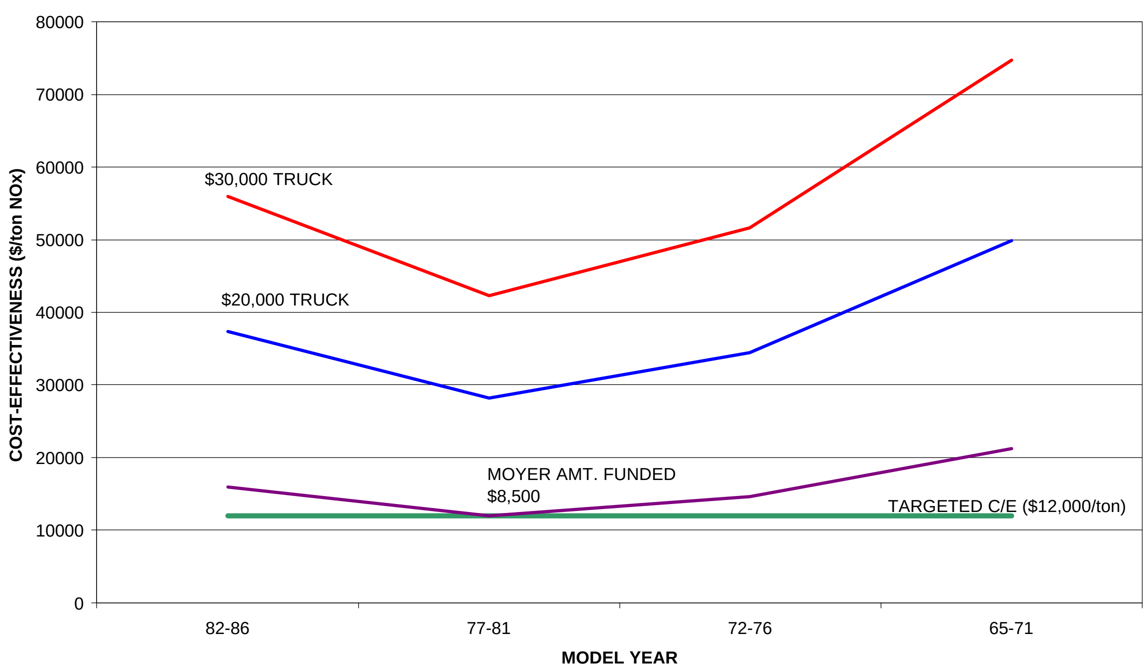
While the technical challenges of repowering pre-1987 trucks with electronic engines could be overcome, the resultant cost may cause this strategy to be economically unattractive. For example, the basic cost for this type of repowering is estimated to be about $30,000, including new engine, radiator, wiring harness, other engine-related components, and labor. If the gearing needs to be changed, and if the transmission needs to be replaced, the cost could increase to about $40,000. Contrasting this cost to the market value of the truck, and anticipated emission benefits, this type of project cannot be justified based on the cost-effectiveness criterion of $12,000/ton. Staff estimates that based on that cost-effectiveness criterion, the maximum Moyer amount that could be granted for this type of repowering project would be about $8,500 to $12,000. This assumes that the repowered truck will be driven the same number of miles and employed in the same service as the older truck. This amount is well below the expected cost for this type of project. The owners/operators for these vehicles generally operate on very slim profit margins and typically would not be expected to have the financial resources to pay for the difference in expected costs. Thus, staff believes that for most of these engines, this strategy may not be successful in reducing emissions.

2. Early Replacement of Pre-1987 Trucks/New Purchase Option

This strategy is an early replacement of pre-1987 truck strategy. The focus of this strategy is to provide incentives for pre-1987 truck owners to retire their trucks and replace them with newer, less polluting, 1994 and later model year, trucks. In many ways, this strategy is very similar to measure M-7 of the 1994 Ozone SIP discussed earlier. It is, therefore, not very surprising that the reasons causing measure M7 to be infeasible are very much the same reasons why the current option is anticipated to be unsuccessful.

The first key issue is funding. Whereas, measure M-7 depended on market forces to fund a self-sustaining program through the sales of some old trucks to oversea markets and through the sales of parts from scrapped trucks, the current proposal would rely on Moyer funds to support this accelerated vehicle replacement program. In this case, Moyer funds would be granted for the purchase of 1994 and later model year heavy-duty trucks. Staff's preliminary assessment of the used truck market shows that the market price for a used 1994 or newer truck ranges from $20,000 to $30,000. Based on staff's earlier analysis for the repowering option, the maximum amount of Moyer fund that could be paid out would be about $8,500 to $12,000 per truck purchased under this program. Again, this is based on a cost-effectiveness criterion of $12,000 per ton of NOx emissions reduced, assuming the new truck will be driven the same number of miles and employed in the same service as the older truck. Figure A-3 illustrates the cost-effectiveness that could be expected for this type program over the range of estimated costs for buying a newer truck. From this scenario, a truck owner would need to expend from $8,000 to $21,500 to obtain the newer truck. It is unlikely that a truck owner would be willing to invest this amount to buy a newer truck under this Moyer program, especially since his/her current truck is still operating. Also, as discussed earlier, the revenue generated from the type of work these trucks are employed in cannot justify this investment.

FIGURE A-3
COST-EFFECTIVENESS OF PRE-1987
HEAVY-DUTY TRUCK RETIREMENT PROGRAM



The second key issue is to ensure that real and quantifiable emission reductions are achieved. Under measure M-7, emission benefits were determined to be much less than originally anticipated when the 1994 Ozone SIP was developed. The reasons being that truck owners really have no incentives to sell their old trucks since the market price for such trucks is severely undervalued relative to their utility to the truck owners. In addition, even when an owner decides to sell the truck, perhaps because the truck has deteriorated to the point where it does not make economic sense to repair it, the owner would very likely buy another truck of similar, or marginally newer, vintage due to financial constraints. Under this scenario, any emission benefits attributable to a vehicle retirement program would be very minimal.

Under the option being investigated, this situation would remain essentially unchanged, even if the old truck were required to be completely destroyed, so that it could not reenter the used truck market. There are various reasons for this observation, mainly due to the dynamics of the used truck market and the economics of this sector.

First, these old trucks are typically employed in services with relatively small revenue and profit by smaller fleet operators. A fleet operator who opted to purchase a newer truck must be able to justify the economics of the added payment for the new purchase. If the newer truck were to be employed in similar service, where the revenue stream presumably would be the same as with the older truck, the added payment for the newer truck would not be justifiable. Some of the added cost maybe able to be offset through fuel savings and reduced maintenance costs associated with the newer truck. But these savings would need to be substantial to improve the economics of the purchase. If, as a result of having the newer truck, the truck owner decides to switch to a more lucrative business that could be performed with the newer truck, the old service would be taken over by other operators. These other operators would very likely use older trucks to conduct business, the type of trucks that this program is trying to eliminate. This is because older trucks can be purchase from both in state and out-of-state truck market, at relatively low prices. Thus, the total population of older trucks would not be reduced significantly even if some truck owners could be entice to participate in the proposed Moyer program.

Another factor that would reduce the emission benefit that could be expected with this program is the off-cycle emissions associated with electronic engines. While the difference in the NOx emission standards for pre-1987 and 1994-and-later heavy-duty engines is more than 5 g/bhp-hr, the actual difference in in-use emissions is much less due to off-cycle emissions. As presented in Chapter II, Table II-6, the baseline emissions for pre-1987 heavy heavy-duty vehicles range from 7.5 g/bhp-hr to 9.8 g/bhp-hr and 1994-1998 heavy heavy-duty vehicles range from 7.3 g/bhp-hr to 8.9 g/bhp-hr. Thus, as a result of off-cycle emissions, the emission benefits of an accelerated heavy-duty vehicle replacement program are not as great as initially appeared.

3. Conclusions

Based on the foregoing analysis, staff believes that incentivizing the early replacement of pre-1987 heavy-duty vehicles would not be justified on either cost or emission benefit considerations. The combination of cost that would need to be funded and the relatively small real emission reductions that could be obtained, causes the cost-effectiveness to be quite high compared to other possible projects that could be funded with Moyer money. A heavy-duty truck owner would be required to put out additional money, not an insignificant amount in most cases, to compensate for the amount not covered by Moyer money. As discussed, a truck owner in this market would not likely have the resources, or the inclination, to do so.

APPENDIX B

APPROVED GUIDLINE REVISIONS

APPROVED GUIDELINE REVISIONS
(BEFORE AB1571 WAS CHAPTERED)

On October 10, 1999, the Governor signed AB1571 codifying the Carl Moyer Program. According to Article 8, section 44287(b), the ARB, in consultation with the participating districts, may propose revisions to the guidelines. However, the proposed revisions must be made available to the public 45 days before final adoption, and the ARB must hold at least one public meeting to consider public comments. Prior to the Governor signing AB1571, however, the Board approved the guidelines and granted ARB's Executive Officer with the authority to modify the guidelines, where necessary, to ensure effective program implementation. As such, ARB, district staff, and industry worked closely to streamline revisions to the guidelines while still funding the most effective projects considering both technical issues, as well as, program continuity.

Some of the revisions that occurred early in the first few months include minor modifications to discrepancies in the guidelines such as omissions, and typographical errors that needed clarification for districts to continue implementing the Carl Moyer Program effectively. The only major revisions pertain to baseline emission factors for marine vessels. These approved modifications are summarized below to provide you with the most current project criteria that district's are using to evaluate and select projects under the Carl Moyer Program.

CHAPTER II – ON-ROAD VEHICLES

C, 2 – Repowers. *This section was modified to allow diesel-to-diesel repowers for only pre-1987 engines. For 1987 and later, repower projects are allowed when a diesel engine is repowered with an alternative fuel engine. Furthermore, under the Carl Moyer Program, funding is not available for projects where gasoline (i.e. natural gas or gas) engines are replaced with new diesel engines or diesel engines are replaced with gasoline engines (excluding natural gasoline).*

Section D, 2 – Emission Reduction Calculation. *This section was modified to include a new table, Table II-4. The table lists new diesel-to-diesel equivalent emission factors to convert from g/bhp-hr to g/mile. These emission factors replace the emission factors listed in the February 1, 1999 version of the Carl Moyer Program Guidelines. The remaining tables in this section have been re-numbered to reflect the addition of Table II-4.*

Table II-4 **Diesel Equivalent Conversion Factors** **for Heavy-Duty Vehicle Projects**			
Model Year	**Medium Heavy-Duty Diesel 14001-33,000 lbs.**	**Heavy Heavy-Duty Diesel 33000 lbs. +**	**Urban Transit Bus [a] 33000 lbs. +**
Pre-1978	2.3	2.9	4.3
1978 – 1981	2.3	2.8	4.3
1982 – 1983	2.3	2.8	4.3
1984 – 1990	2.3	2.7	4.3
1991 – 1995	2.3	2.7	4.3
1996+	2.3	2.6 [b]	4.3

a. Urban transit buses over 33,000 gross vehicle weight rating (GVWR) or school buses over 33,000 GVWR in an urban area.
b. 2.6 bhp-hr/mile is for all heavy-duty line haul trucks (class 8).

Table II-5 (formerly Table II-4) has a new footnote defining a Class 8 heavy-duty vehicle to include 40-foot school buses and heavy-duty diesel vehicles with a gross vehicle weight rating greater than 33,000 pounds (i.e. refuse trucks and street sweepers).

Section D, 3 – Example 2: Urban Bus Purchase. *This example was modified to allow districts to approve funding for full incremental cost of transit bus engines on a case-by-case basis. The transit district must demonstrate the need by documenting a transit agencies funding allocation (including source of funding), adopted procurement schedule, historical bus replacement data, the types of alternative fuel buses they want to buy (including cost), and the number and cost of diesel fuel buses they would buy in lieu of the alternative fuel bus.*

Section E – Reporting and Monitoring. *This section was modified to include a requirement for participants in the Carl Moyer Program to maintain operating records and have them available upon district's request, not only for the life of a project.*

<u>CHAPTER IV - LOCOMOTIVES</u>

Section B – Project Criteria. *The project criteria were revised to require that all NOx reduction go beyond what is required by any legally binding documents. A new requirement was also added stating that the U.S. EPA test procedures must be used to test locomotive engines. Although the initial guidelines were written with the intent of applying these criteria to all categories where applicable, both criteria were unintentionally omitted.*

- NOx reductions for all other districts must beyond what is required by any federal or local regulations or other legally binding document;

- NOx emissions must be tested according to U.S. EPA test procedures for Locomotives – ISO 8178-4:1996 Test Cycle F-"Railroad Traction";

Section C.1. – Repowers. *This section was modified to require that the replacement engine be tested according to U.S.EPA test procedures for locomotives as follows:*

However, in order to qualify for funding, locomotive engines must test to a reduced-NOx emissions level according to U.S. EPA test procedures for locomotives.

Section C.2. – Retrofits. *Language was also added to this section to emphasize that locomotive retrofit kits must test to a reduced NOx emission level according to U.S. EPA test procedures for locomotives as follows:*

Similar to repowers, in order to qualify for funding, locomotive engines must test to a reduced-NOx emissions level according to U.S. EPA test procedures for locomotives.

Section D.1 - Emission Reduction Calculation. *The third sentence of this section was modified to define the energy consumption factor of 20.8 bhp-hr/gal as a diesel-equivalent energy consumption factor. This is also true for all source categories. If not stated otherwise, all conversion factors represent diesel equivalent emission factors.*

Section D.3. - Example 2 – Locomotive Engine Replacement. *This section was also modified to define the average fuel consumption rate of 260 gallons per hour "260 diesel equivalent gallons per hour."*

<u>CHAPTER V – MARINE VESSELS</u>

Section B. -- Project Criteria. *This section has been modified to include three additional project criteria. First, NOx reductions must be beyond what is required by any existing regulations, memorandum of understanding, or legally binding documents. Secondly, ARB will allow marine vessel projects to be funded where there is an increase/decrease in horsepower. However, if the horsepower rating of the new engine differs from that of the existing engine by 25 percent, the difference in the rating must be taken into account in the emission reduction calculation. ARB is requiring districts to consider the difference by multiplying the estimated emissions from the new engine by a factor, as follows:*

$$\text{Modified Emissions} = E_{new} * \frac{\text{Rating of new engine}}{\text{Rating of old engine}}$$

where, E_{new} = the emissions from the new engine

Lastly, NOx emissions must be tested according to U.S. EPA test procedure ISO8178-4:1996(E), 8.5, Test Cycle Type E – Marine Applications.

Section C, 1 – Repowers & Retrofits. *This section has been modified to include a provision that prohibits Carl Moyer Program funding for projects where gasoline (i.e. natural gas or gas) engines are replaced with new diesel engines or diesel engines are replaced with gasoline engines (excluding natural gasoline). In addition, the ARB will* *allow the emission factors listed in Table V-5 to be used for estimating baseline emissions (i.e. emissions from existing engines) from marine vessels participating in the Carl Moyer Program. These factors supercede those listed in Chapter V, Table V-5 of the Carl Moyer Program Guidelines dated February 1, 1999.*

These emission factors apply to engines in the original engine manufacturer (OEM) configuration. If the engine has been modified to produce lower NOx emissions for any reason, these factors are not applicable. For engines modified from the OEM configuration, baseline emission factors must be based either on manufacturer's emissions data or in-situ source test data. In lieu of using these new emission factors, baseline emissions may still be determined by using ARB approved in-situ source testing (Diesel Marine Vessel Emissions Testing Protocol, SBCAPCD, July 1999). If source testing is performed, test results must be used even if testing indicates lower or higher emission factors than the default factors listed. The maximum acceptable value of a baseline emission factor derived from in-situ source testing is 20 g/bhp-hr.

Table V-5
Harbor Vessel Emission Factors – Medium Speed Diesels
(g/bhp-hr)

Emissions Configuration	2 Stroke[a] Naturally-Aspirated (g/bhp-hr)	2 Stroke[a] Turbocharged (g/bhp-hr)	4 Stroke[b] Naturally-Aspirated (g/bhp-hr)	4 Stroke Turbocharged[b], Turbocharged/ aftercooled (g/bhp-hr)
Uncontrolled (Pre 1980)	14[c]	11	8	7
Off-highway 1980+ (Pre-EFI)[d]	8	7	7	6

Notes:
a. 2 Stroke = Typically DDC-53 or –71 series
b. 4 Stroke = Cat/Cummins and others
c. The 14 g/bhp-hr baseline is listed for EMD engines used in marine applications
d. EFI = Electronic Fuel Injection

Section D, 3 -- Examples. *The example has been modified to include a realistic annual fuel consumption that reflects the size and power of the engine used in the example. Emission reductions and costs have been modified to reflect this modification.*

APPENDIX C

THE CARL MOYER PROGRAM GUIDELINES, FEBRUARY 1, 1999

APPENDIX D

FORKLIFTS AND AIRPORT GSE GUIDELINES APPROVED 10/12/99